DISCOVERY

A Monthly Popular Journal of Knowledge

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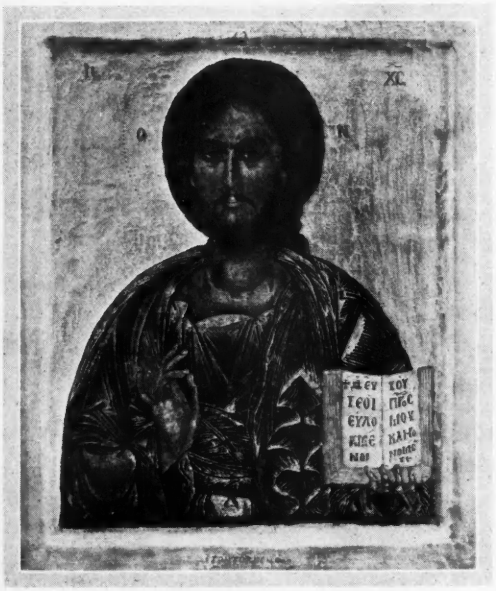

THE CHRIST OF THE BYZANTINES.
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Trustees: Sir J. J. Thomson, O.M., F.R.S., Sir F. G. Kenyon, K.C.B., F.B.A., Professor A. C. Seward, Sc.D., F.R.S., Professor R. S. Conway, Litt.D., F.B.A.

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Notes of the Month.

To physicists and chemists the association of the words "positive" and "electron" was until the other day as unthinkable as the association of "negative" with "matter" or with "pressure." But the oddness of the phrase has been forgotten in the interest aroused by recent observations in the Cavendish Laboratory at Cambridge, where the possibility of the positive electron's existence has been established. The negative electron, the massless unit charge of electricity, was isolated first in the Cavendish Laboratory by Sir J. J. Thomson in 1897; its opposite, often envisaged by theorists although never with much confidence, has apparently now revealed itself thirty-five years afterwards. One curious feature of this revelation is that its begetter should be the penetrating or cosmic radiation which, although known for more than twenty years, was not realized to be of either interest or importance until a few years ago.

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Last month in these notes it was stated that the cosmic ray had been found sometimes to show effects in certain measuring instruments most plausibly due to pieces of an atom which had been split in many places by the ray. One of these instruments, known as a Wilson cloud-chamber, enables the track of a particle passing through it to be photographed. By an ingenious device Dr. P. M. S. Blackett causes the entry of the particle into an apparatus above the chamber to turn on the recording instrument, so that the behaviour of the particle in the chamber can be inferred from the kind of track it makes there. In the presence of a very strong magnetic field the track of an electron —one of the pieces broken off from an atom after impact with the cosmic ray—can be slightly deflected in one direction, and this bent track is readily recognized by the experimenter as due to a single electron. It has now been observed that sometimes concurrently with this bent track there is a very similar track bent equally in the opposite direction. As one is due to an electron, a fair inference is that the other is due to a positive electron. It should be said, of course, that before this conclusion was arrived at other interpretations of this new track were attentively considered.

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The two points, then, are that experimentally there is now a case for the existence of a positive electron, and that this particle is apparently one of several pieces which can result from impact of matter in the atmosphere with the cosmic or penetrating radiation. Hitherto positive, unlike negative, electricity has always been found in association with matter. From a neutral piece of matter, such as an atom, a massless negative charge of electricity, the electron, can without difficulty be removed, so that what remains behind must be described as bearing a positive charge, not because it bears anything "positive" in the ordinary sense of the word, but simply because the unit charge which the neutral atom has lost has always been conventionally called *negative* electricity. The latter is the existent thing; the positive charge, until the other day, was regarded quite genuinely, although paradoxically, as a mere negative property of matter; it arose from a loss.

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Now it would appear that this view was over simple, and it will be interesting to learn what remains when the positive charge itself is knocked away from matter. In a simple case like the hydrogen nucleus the answer is not hard to guess. This, as is well known, is a mass of unity with a single positive charge associated. If it were deprived of this charge it would be a mass of

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one with no charge—in other words, the neutron, which was discovered last year about this time. The new result makes it plausible that the neutron may not be, as has hitherto been thought, the intimate union of a positively charged hydrogen nucleus with an electron but, much simpler, the positively charged nucleus without the charge.

* * * * *

In the courtyard of the Cavendish Laboratory the new Royal Society Mond Laboratory was opened last month by Mr. Baldwin. The construction of this laboratory is the outcome of research developed by Dr. P. Kapitza in the Cavendish Laboratory during the past ten years. The main object of this unexciting but important work has been the investigation of the properties of matter when subjected to enormously intense magnetic fields. It is now essential that this study should be continued at very low temperatures, and for this purpose the new laboratory has for some time contained apparatus for making both liquid nitrogen and the far colder liquid hydrogen; now it is to have plant for producing the ultimate liquid of all low-temperature or "cryogenic" work—liquid helium. These experiments, however, are for the future. The big advance that Dr. Kapitza has made in this subject is the production of the enormous magnetic fields. If a very large magnet is used, or if very large currents are sent through its coils, large magnetic fields can be made, but these are trifling compared with those which Dr. Kapitza considers necessary for his investigations and which he can now produce.

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Dr. Kapitza's method is to use a coil of material capable of withstanding enormous mechanical stresses through which he passes very large currents; then at a given moment he short-circuits the system for a fraction of a second, thereby inducing, throughout a small volume of a few cubic centimetres, a magnetic field five or six times greater than the best recorded elsewhere. Everything is ingeniously synchronized so that in the very short time when the magnetic field is on, all the instruments measuring the property under investigation are working in full swing. The currents and the fields are such that if they were retained for more than a small fraction of a second the whole apparatus would be completely destroyed. The results so far obtained sound very technical when described. The property of magneto-striction in non-ferro-magnetic bodies has been found. A new law of variation of the resistance of metals with the magnitude of the applied magnetic field has been discovered, and so on. The combination of excessive cold with large magnetic fields is certain to yield results in the future of high interest.

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A helicopter invented in Austria is undergoing tests in this country. It is claimed that the machine is capable of taking off and descending vertically, remaining stationary in the air and flying backwards. Experiments with a helicopter were for some years carried out at Farnborough, but appeared to have no practical results. With the subsequent success of the autogiro, the helicopter has fallen into neglect, but the tests of the Austrian machine are likely to attract new attention to its possibilities. The autogiro is not strictly a vertical machine, but it has lately been developed by the Air Ministry who have just placed an order for the latest model. The new experiments recall the fact that the Air Ministry some years ago offered a handsome prize for the invention of a helicopter which was never won. The tests now being made will therefore be watched with interest.

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The Physical Society's award of the tenth Duddell Medal to Professor Wolfgang Gaede, Director of the Physical Institute at Karlsruhe, is a well merited honour. Professor Gaede's name will always be associated with the design and production of high vacuum pumps, which during the last quarter of a century have revolutionized vacuum production. Before 1905, when Professor Gaede invented his first mercury pump, the production of a vacuum beyond that attainable with a filter or piston pump was a tedious operation. Less would undoubtedly be known to-day of the important phenomena occurring at low gas pressures if Gaede had not made vacuum pumps his life-work. The modern electric lamp and the thermionic valve are, of course, familiar outcomes of this work. Professor Gaede's latest development is the large diffusion pump designed for work at Leiden on solid helium. While he has not been alone in designing the high vacuum pumps now in common use, he provided the basis on which many others are built, and independently introduced all the methods which are used in present-day pumps.

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The invention of a "cold valve" is likely to revolutionize the design of radio sets. Research on this device has cost hundreds of thousands of pounds, and may take wireless receivers back to the simplicity of the early crystal sets. It dispenses with the use of accumulators and high tension batteries, and is being incorporated in special wireless sets which are shortly to be available to the public.

Some Rare Byzantine Paintings.

By Stanley Casson.

Examples of early Byzantine paintings are extremely rare. The recent exhibition in London has made it possible for those interested in the early styles and technique of East Christian art to study at first hand some lovely examples of the painted panels which were executed by Byzantine artists.

PERHAPS no aspect of European painting has been more neglected than the Byzantine, and none is likely in the future to prove more fertile for research. The history of painting in Constantinople and the Christian east is obscure. The painted panel as such is believed to have been developed from the canvas and wooden panels, bearing portraits, which were used in Egypt in late Roman times to adorn the heads of mummy-cases, and to depict the dead. In the sixth century panels of wood painted in tempera are found, painted in a style which is the direct forerunner of Byzantine methods. The portrait of a bishop from his tomb at Bawit in Egypt of this date, now in the Kaiser Frederick Museum at Berlin, shows the authentic manner of Byzantine painting.

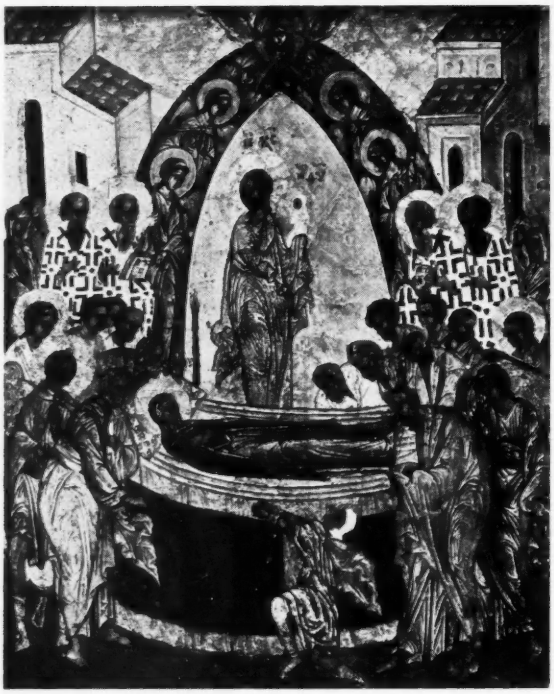
The gap between the sixth century and the eleventh is hard to fill. The destruction caused by the Iconoclasts in the ninth century probably removed most of the painting and icons of the preceding age. Large panels of the eleventh and twelfth century have survived in some few instances, of which the famous Madonna of Vladimir in Russia is a notable example. Russia, indeed, contains more early Byzantine icons than the rest of Europe, for the looting of Constantinople by Latins and Turks effectively destroyed the bulk of the paintings of earlier ages. All that we know for certain is that the style, technique and perfection of Byzantine painting was fully achieved by about 1100, at a period well before any panel painting was known elsewhere in Europe.

The earliest style of Byzantine panel painting follows closely the style of mosaic work. In the well-known mosaics of Daphni, near Athens, and of the monastery of St. Luke in Phokis, we can see fully illustrated both the scheme of colours and the methods of style and composition of the eleventh century. The few paintings accessible of this period fully agree in style with the mosaics. Undoubtedly the Byzantine painter was most fully equipped and completely competent at this time. Byzantine art is now emerging as the art which influenced, and soon controlled, the whole growth of painting and sculpture in the rest of Europe. The earliest Italian painting differs only in execution and in its choice of colours from the Byzantine. On the whole the difference is the difference between the pupil and the master.

In this exhibition, unfortunately, there was nothing of a date earlier than the twelfth century, and the one example of that period was small and ill-preserved. But the Byzantine style, once fixed and fully established in the eleventh and twelfth centuries, persisted with strange vigour for many centuries later. Although in the fourteenth century Byzantine painting and mosaic-work fell profoundly under Italian influence, and the master was now being moulded by the pupil, yet there survived, unaffected by Italy, the earlier and more severe style which we see in the Daphni and Phocian mosaics. These two styles last side by side and at intervals reappear unexpectedly right down to the eighteenth century. Difficulties of dating in Byzantine painting are, in consequence, almost insuperable, and only by technical means can the date of an icon be established in some cases without an error often of a long period of time.

THE CHRIST OF THE BYZANTINES.

The traditional Christ of the Byzantine world. This was probably painted in the fourteenth or fifteenth century and displays a characteristic absence of emotional feeling. All the pictures are the property of Mr. C. T. Seltman.



"DEATH OF THE VIRGIN."

The arrangement of the figures is a striking feature of this panel.

One thing, however, is certain, that Italian influence in Byzantine painting is not really a full controlling influence until the sixteenth century. By this time the artists, dispersed at the fall of Constantinople in 1453, had fled to the monasteries and cities of the Greek world as far as they could get from Turkish domination. Crete and the Ionian islands, being under Venetian control, were safe homes, and here much painting was done. But the presence of Italian artists and Italian works of art soon influenced the Byzantines. The Greek painters of Crete of the sixteenth and seventeenth centuries, of whom many are known by name, show this Italian influence by a tendency to spread their design and composition and to replace the compact precision of the authentic Byzantine style by a looser arrangement of forms and elements of the composition on the panel.

The group of pictures here illustrated show with great clearness the various changes which I have just described. The first is a superb painting of Christ as the Pantocrator. The whole of the background is of gold and the figure is in sombre browns and purples, picked out with gold lines. The dark face, delicately lit with a faint light, is the stern and severe face which one sees in the mosaics of the eleventh century. Here is the traditional Christ of the Byzantine world. But it was probably painted in the fourteenth or even in the fifteenth century, and the style of painting, by its archaic simplicity and absence of emotional feeling, appealed to certain types of painters until a relatively late date.

The second painting is a small panel which shows the scene of the "Death of the Virgin" popular in the East and almost unknown in Italy and the West. The composition is as concise and compact as can be found in Byzantine painting. The influences at work here are not Italian, but rather the style of painting that grew up in the North Balkans and in Dalmatia. The impressive arrangement of the figures so as to combine a horizontal theme with the vertical lines of the centre is very remarkable. The figure of Mary, dead, is seen on the richly covered bier. Behind her appears the figure of Christ bearing the soul of the Virgin to heaven. The Christ is painted in gold and pale yellow against a background of rich blue.

The garments of the Virgin are in a rich maroon-purple, and the pall on the bier is black. The architectural background is light, with rich red roofings. The blend of rich warm colours in this picture is essentially Byzantine, with little or no Italian influence. The scene, like all Byzantine scenes, is conceived of as mainly dark, illuminated by the central blaze of light which falls gently on the surrounding figures. In this, as in most Byzantine paintings before the sixteenth century, one sees the methods of design and lighting influenced by the manner in which painting was done. It must be remembered that most Byzantine panel painting and manuscript illumination was done by monks in dark cells. They thought of the figures of their compositions as they thought of the figures they saw round them—faintly lit by a falling light.

The Italian Primitive.

In direct contrast is the painting of the Italian primitives which, although Byzantine in subject and structure at the outset, are soon painted with the full light of the open air on their figures. The Italian painter worked in open cloisters or, perhaps, not in a monastic setting at all. His figures, and with them all the figures in west European painting, are thought of as in the open light with shadows here and there showing up against what are essentially fully-lit scenes. El Greco, whose genius soon adopted full western customs and manners, and whose style was strictly personal and not derivative from any known source, was still a Greek, born and trained in Crete. Throughout he thinks of figures in the old monastic

manner, as faintly lit from a distant and dim light, the bulk of the figure being in the dark. This was his main heritage from eastern art.

Byzantine Traditions.

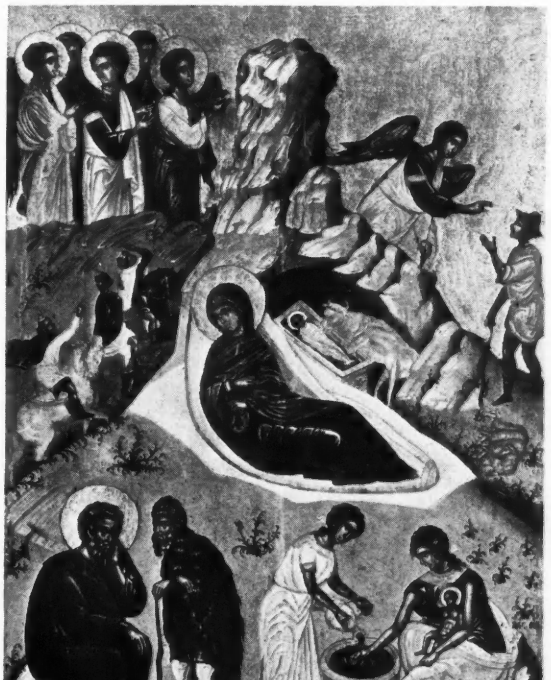
The third picture here illustrated shows a Greek artist working in Crete. Here he has used the traditional scene of the Nativity, but has spread the composition out. It is also conceived as a scene in the open air and yet so strong are the old Byzantine traditions that he has still painted the two lower figures in the left bottom corner—Joseph being comforted by a shepherd—as lit in the faint light of a dark setting. The light just strikes on the faces and garments, which otherwise remain in obscurity, and yet the ground and rock on which the figures stand is bright and sunlit. Equally Byzantine still is the group of angels at the top, chanting among the hills. But the lively scene of the women at the bottom and of the shepherd boy at the top are no longer Greek. They are due to the effect that Italian art was now having on Greek painters.

Less Italian, but still affected by Italian work, is a strange picture of the "Mourning at the Tomb," signed by an island artist called Nomikos. Here the colours are bright and sharp but the composition Byzantine. A shrieking figure of woe introduces a dramatic note into a manner of painting that had hitherto strictly avoided drama, description and story-telling. Byzantine art either in mosaic or in panel-painting had seldom if ever told a story or pointed a moral. The great figures of Christ or of the Virgin in all the Byzantine world of the tenth to the fourteenth century had always been hieratic figures, transcending human concerns. Only in the fourteenth century mosaics of the Church of St. John in Chora in Constantinople did artists begin to relate historical events and biblical stories, and even then they did so with restraint. But in this picture there is a deliberate attempt to humanize a scene. There is emotion depicted, however naïvely, in each figure.

In its love of gold backgrounds and of the glitter of gold as a medium the Byzantine artists showed their love of splendour. It must be remembered also that almost all Byzantine painting and mosaic would have been seen by a very dim or by an artificial light. Gold was, in consequence, a help in the creation of the desired effect. Colours, without being vivid, had to be made clear, so that one finds that all Byzantine colours are strong and rich, never pale or thin.

From these relatively late paintings one can see the brilliance of Byzantine achievement in painting. The artists limited their conventions rigidly but found within their conventions endless possibilities of variation. This is the quality which links up Byzantine genius with that of ancient Greeks, who also but in a different way made genius consist of the power to achieve subtle variation in accepted themes on a basis of accepted styles.

The tenth, eleventh and twelfth centuries are the greatest periods of Byzantine art. The fourteenth century marks a change into a manner more humanistic and more lively. In 1453 came the great break up of Byzantine culture and after that date artists painted in remote monasteries and in far places away from the centre of disturbance. Painting was still carried on to the nineteenth century in the Byzantine manner, but technique had decayed and style vanished. The vast mass of utterly inartistic icons of the period from about 1650 to 1850 has for too long been the test by which Byzantine painting has been judged. The rarity of the earlier paintings had made it difficult to revise judgments based on this inferior material. But at this exhibition much has been assembled, for the first time in England, by which judgments of a more considered nature can be achieved.



SCENE OF THE NATIVITY.

A beautiful panel painting by a Greek artist working in Crete.

Plants and Daylight: New Experiments.

By M. A. H. Tincker.

Keeper of the Royal Horticultural Society's Laboratory, Wisley.

The response of plants to daylight has been the subject of experiments under the direction of the author. Certain cultivated species have been subjected to varying periods of natural and artificial light and the effect on flowering has been noted. The study has also been extended by other workers to birds and insects with interesting results.

MANUFACTURERS exercise complete control over their machinery, but as yet producers of agricultural and horticultural commodities are more dependent upon the reactions, often apparently capricious, of their manufacturing units—the animal and plant. An experimental analysis of the behaviour of such organisms may thus prove of both biological and practical interest.

The following review deals chiefly with investigations of the behaviour of cultivated plants. Brief mention will, however, be made of parallel phenomena in the animal world. The investigations attempt to elucidate further, certain aspects of the reproductive activity of flowering plants; previously the production of flowers and fruits had often been regarded as a seasonal, or periodic, activity of the plant.

Early Experiments.

The early experiments were carried out some fifteen years ago by Garner and Allard as a result of difficulties they experienced in making a variety of tobacco (Maryland Mammoth) produce flowers. In certain latitudes the plants only grew vegetatively, they produced no flowers; when transferred to other latitudes in which the days were shorter and the nights longer, blossoming took place. Differences in temperature and nutrients were ruled out as possible explanations.

Garner and Allard promptly devised a series of experiments to test the reaction of a number of plants to long and short periods of daylight and artificial light. This was accomplished by daily placing the plants in a darkened shed at stated times and by prolonging the natural light by weak electric light. Due care was exercised to prevent differences in temperature and other factors. They were rewarded by exceedingly interesting results; their experiments have been repeated successfully in many countries and more and more plants have been tested. The term "photoperiodism" has been coined to distinguish the observed phenomena of which only examples can be considered.

When cosmea or *Cosmos bipinnatus* is grown under short daily periods of sunlight of nine or six hours' puration, flowering rapidly takes place and in a few weeks fruits are formed. Grown under long periods of light of fifteen or sixteen hours' duration daily, vegetative growth continues for many months and exceedingly large plants devoid of blossom result. The vegetative growth as measured by height, leaf formation, or in other ways varies as the length of the period of illumination. Several generations may be raised in a year under short daily periods of light. Similarly chrysanthemums can be brought into blossom in early summer by subjecting young cuttings or seedlings to short daily periods of light. Control plants receiving the full period of natural light flower some three or four months later. Such observations have already been applied to horticultural practice in countries where the demand for "out of season" flowers repays the small extra labour involved in darkening the plants each day.

Millet is another plant which reacts in this way, but the soy bean affords the classic example. A large number of varieties have been tested both by manipulating the periods of light artificially and by altering the date of sowing in the open. It was soon observed that the "late" and "early" varieties, while all showing the same type of response, were not equally susceptible to short periods of light. By this technique a ready means of testing the potential

WHEAT PLANTS.

An English wheat (left) and two Australian varieties receiving ten hours' daylight and six hours' weak electric light. They were photographed five months after sowing. (Reproduced from "Annals of Applied Botany.")

behaviour of varieties in other latitudes became available, as did also information regarding the suitability of varieties for fodder or rapid seed production in stated latitudes. Plants reacting like cosmea, chrysanthemum, and soy beans have been termed " short day " plants. An interesting point made by the early experimenters was that a continuous period of darkness and light was required to evoke these responses. An interrupted period of light, caused by mid-day darkening, did not produce the short day effects ; or stated another way, two separated periods of three hours' light did not influence the plant as did one exposure of six hours followed by eighteen hours in darkness.

Another group of plants, termed " long day " plants, produce flowers more rapidly when grown under long periods of light ; they grow vegetatively under shorter periods of illumination. Familiar examples are wheat, barley, oats, many of our British grasses, and such fodder plants as red clover (*T. pratense*), and in our gardens love-in-a-mist (*Nigella damascena*) and *Sedum spectabile*, which usually flowers in early autumn. When standard English and Welsh varieties of wheat and oats are subjected to short (nine or ten hours) periods of light each day they continue to grow slowly and produce many branches, and so come to resemble a tufted grass in habit.

Such plants completely omit the usual seasonal changes—that is, they do not become erect nor do they flower, nor do they function as annuals but grow on for a second or third year. Similarly, plants of *Sedum spectabile* have been held for many years in the vegetative condition ; *Nigella damascena* under short period of light remains as a " springtime " rosette of healthy leaves throughout the entire season. No doubt the seasonal changes from rosette to erect habit shown so well by the weeds in pastures partly depend on the seasonal period of daylight.

The Behaviour of Wheat.

A closer examination of the behaviour of varieties of wheat and red clover, for example, reveals a relationship between the source of origin of the variety and its photo-periodic response. Australian wheats, such as " Rajah " and " Ranee," are able to flower and produce grain under short nine-hour daily periods of light which, as we have seen, prevent English varieties from flowering. Again strains of red clover from Southern Europe may flower freely under nine-hour periods of light while the valuable Montgomery strain remains as a dense " mat " of prostrate growth with no blossom under a period of light as long as thirteen

PLANTS OF *SEDUM SPECTABILE*.

(Left to right) Plant grown in natural daylight showing ripening fruits ; plant subjected to twelve hours' daylight and five hours' electric light ; plant given twelve hours' daylight, with leaves dropping and no flowers ; plant given six hours' daylight, with no flowers

hours. From these and other wider studies made with certain cereals, it is concluded that the prevalent agronomic methods of harvesting and of conscious selection have resulted in rejection of the individuals and varieties not adapted to the local seasonal period of light. The failure of " imported " varieties experienced by wheat growers in Australia with English varieties, and vice versa, is now more fully elucidated.

Mention must next be made of plants like annual meadow grass (*Poa annua*), that troublesome weed of garden paths which flowers almost all the year round, and under experimental conditions has produced seed in a range of from five to twenty hours of light. In marked contrast stands the behaviour of *Tephrosia candida* (a sub-tropical and tropical legume) which responds to a small alteration of less than one hour in the daily period. It is nowadays apparent that a classification into short and long plants is arbitrary, as no sharp dividing line can truly be drawn. Species and varieties and " pure lines " react characteristically to the daily period of light but vary in susceptibility to changes of this period, and also in the width of the range in which they can flower.

As the intensity of the supplementary light given to plants receiving natural daylight may be very low—a few candle power such as used in house illumination is sufficient—and yet produce these responses, plant breeders have been able to accelerate the flowering of cereals by obtaining two generations in the year ; three generations of beetroot (*Beta vulgaris*) have been grown. Breeders are also enabled to cross varieties or species which would not otherwise be in flower contemporaneously. This has already been done

with maize and teosinte (*Reana luxurians*) and with grasses.

With hemp (*Canabis*) short periods of light evoke a flowering response; subsequent long periods of light cause a resumption of vegetative growth of the lateral buds, which is accompanied by a modification of the usual arrangement of the leaves on the stem.

Changing Sex.

A yet more interesting phenomenon observed with a dioecious variety of hemp, having male and female plants, was the sex reversal of plants under short periods of light; every male plant changed and expressed "femaleness." Again in certain varieties of maize eighty per cent of the plants were made to show sex reversal in the "tassels" or male inflorescences. The change was from male to "femaleness" under short periods of light, but under long periods "maleness" persisted. Every possible type of sex mosaic, including mixtures of male, female and neuter flowers, has been experimentally induced, the diversity of sexual expression reflecting a diversity of physiological conditions under which the plants grew. Responses in floral development can be strictly localized in the plant; for example, with cosmea grown under long periods of light covering one small branch with black silk will induce in this branch a typical short day reaction; the remainder of the plant reacts differently and grows vegetatively.

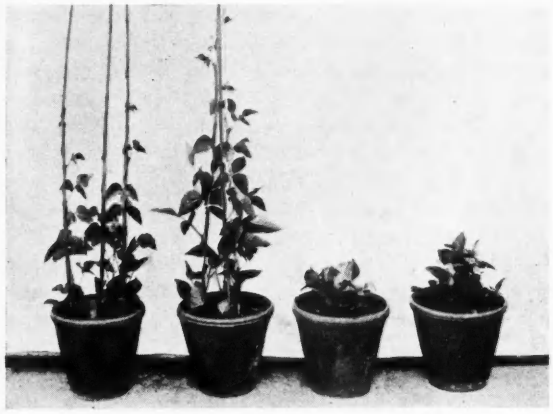
The hog peanut (*Falcata formosa*) illustrates a curious reaction. As is well known, this plant forms green aerial closed flowers which give rise to buried seed pods. These cleistogamic flowers occur in autumn, and in summer normal blue-coloured flowers are produced. Experimentally it was found that cleistogamic flowers and hypogeal pods could be produced in a range of light of from five to thirteen and a half hours. Under longer periods of light only blue flowers were produced. Weak electric light used in winter to prolong the daylight prevented the formation of cleistogamic flowers and hypogeal fruits. Thus the seasonal behaviour of this interesting plant was analysed.

The controlling influence of the period of light on the rate of elongation of the stem can well be seen in the artichoke, where under long periods of light upward growth continues, but under short periods of light growth is slower and ceases at an earlier date. The often troublesome "bolting" of lettuce may be prevented by short periods of light; rapid elongation followed by flowering takes place under long periods of light. The varietal response of lettuce is so strongly marked that a classification of varieties for winter and summer use has now been made on the basis of experimental and field tests. The runner bean (*Phaseolus multiflorus*) of Mexican parentage or origin is here grown as a tender annual. Under our long summer days rapid elongation of the twining stems takes place; periods of twelve, ten or nine hours or shorter duration prevent this climbing habit and the plants grow branched, dense and "bushy." Such dwarf plants bear thick, tough leaves having a modified anatomical structure. The palisade cells are abnormally long. Starch accumulates at the nodes of the stems and in the petioles and rapidly swelling root. In the climbing plants carbohydrates do not accumulate so quickly but are presumably utilized in growth and the production of fibres in the stems. In the tomato also similar modifications of the leaf anatomy have been studied; and in a variety of plants the production of stem fibres (*collenchyma*) has been shown to be related to the period of light under which the plants are grown.

The influences of the period of light upon the utilization of the photo-synthetic products is best shown by tuber-forming plants, such as the potato and other *Solanums*, the Jerusalem artichoke (*Helianthus tuberosus*) and Chinese artichoke (*Stachys tuberifera*) and dahlias, etc. Generally these plants react similarly. Under the long periods of light of a northern European summer, species from semi-tropical America, such as *Solanum acaule*, grow well but produce a poor crop of tubers. Under medium periods of some ten, eleven or twelve hours' duration rapid storage of starch (or inulin) takes place in the fast growing tubers. Dahlia cuttings may be made to form tubers at an early stage of growth by reducing the summer period of light; complaints have been voiced in the horticultural Press at the waywardness of cuttings of "sports." When taken from the parent plant late in the season, they immediately form tubers! With additional light the upward growth of the stem continues and tuber formation is delayed.

Local Responses.

This response of the plant can also be localized, so that one portion may form tubers while vigorous vegetative growth takes place elsewhere. The apical growing point of a branch stem is the sensitive region and the stimulus passes more readily downwards. An intensified effect may be obtained by covering larger areas of the young stolons. The storage of food substances in bulbs may also be accelerated, as in the onion. Here a long period of light is required. The well-known failure of many varieties of onions in the



TYPICAL PLANTS OF THE RUNNER BEAN.

(Left to right) Natural daylight; twelve hours' daylight and five electric light; twelve hours' daylight; six hours' daylight. Photographed ten weeks after sowing. This and the preceding photograph are from "The Journal" of the Royal Horticultural Society.

tropics is probably partly due to the shorter periods of light. The varieties "Prizetaker" and "Bermuda White" when grown in the tropics (eleven hours' light) produced no bulbs, but with additional weak electric light making a total period of thirteen and a half hours, well formed bulbs were obtained.

The rapid storage of starch (or inulin) in developing tubers, and of other carbohydrates in bulbs, affords some information concerning the metabolic activity of the branch. Further chemical data have been collected by analyses of the tissues of plants growing under controlled periods of light. These data have frequently been expressed in the form of a ratio of starches and sugars to nitrogenous compounds—nitrates and amido-compounds—and the symbol C/N has been employed. A welter of conflicting evidence exists as to whether this ratio is associated with the behaviour of the plant; in one series of experiments in which tomato, salvia, buckwheat and other plants were grown under controlled periods of light and nitrate supply, flowering took place only when this C/N ratio was not abnormally high or low; transference of the plants from conditions which prohibited blossoms to conditions which induced flowering was accompanied by a readjustment of the ratio. Again with cocklebur (*Xanthium*) confirmatory evidence was obtained; under short days and with high temperatures the ratio C/N rose more slowly than in plants grown under long days with low temperatures; these changes were associated with observed differences in the time of flowering.

Much other evidence, collected from annuals, biennials and perennials, which cannot be discussed here, also exists. Evidence to the contrary has been derived from an elaborate and costly series of experiments made at the Boyce Thompson Institute, where by employing a battery of very powerful electric lights plants were grown under constant intensity of light and constant temperature. The daily period of illumination was varied from twenty-four hours continuous light to short periods of only three hours daily. Generally it was observed that the ratio C/N varied within wide limits without being correlated with the floral response. If the C/N ratio be finally proved to be closely associated with the floral response of the plant, that does not necessarily imply that it *causes* the response; the reverse may be true, or both the ratio and the response may be caused by some other factor operating by an unknown mechanism.

In the experiments with a constant intensity of illumination the characteristic responses to short and long periods of light were obtained with a large number of plants, thus emphasizing the importance of the *length* of the light period. However, some species grew well in continuous light; clover, for example, in continuous light and with an increased concentration of carbon dioxide (tenfold increase) rapidly reached maturity; other plants, such as tomato, reacted unfavourably to continuous illumination. Continuous darkness has long been known to cause etiolation or pathological symptoms, including abnormal lengthening of the internodes, poor development of chlorophyll and leaf surfaces. These objectionable features are not generally evident with periods of light of three or four hours daily.

Experiments with Light.

Plants have been grown under alternating periods of artificial light and darkness which do not occur in nature; both long day and short day plants were grown under a series of equal periods of light and darkness of a duration of twelve hours, one hour, thirty minutes, fifteen minutes, one minute, down to five seconds. The progressive decrease in the intervals of light and darkness was accompanied by a progressive decrease in the vegetative vigour of the plants, but etiolation was only apparent with certain short intervals (*e.g.*, one minute); under the shortest periods of light and darkness an improvement in vegetative growth was noticed. With cosmea, intervals shorter than one hour were unfavourable for flowering; with larkspur, a long day plant, a similar response in general vegetative vigour was noticed, but flowering occurred under very short alternating periods of fifteen minutes, one minute and even fifteen seconds

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and five seconds duration. Briefly, both long and short day plants reacted in flower formation to such interrupted periods of light, as if the light were continuous; they were unresponsive to the quick flickerings of the light. Probably this is related to the time necessary for the plant to perceive the stimulus and also to respond. The process of opening and closing of the stomata of the leaf usually occupies about twenty minutes and a very brief exposure to light, of for example a minute, is frequently ineffective in causing the guard cells to react.

The effect of a cycle of light and darkness based on a period of forty-eight hours in which the plants were illuminated for fifteen of the forty-eight hours, was similar though weaker than that caused by a seven and a half to twenty-four hours period of light in a daily cycle; a weak short day effect was obtained.

With the common liverwort, *Marchantia polymorpha*, prolongation of the winter daylight by six hours of weak artificial light caused the rapid production of tissues bearing the male reproductive organs (*i.e.*, antheridiophores). Under short periods of light the plants remained in the vegetative condition. The stimulus would therefore appear to be perceived by both the spore-producing flowering plants and by the gamete-producing liverwort.

Certain mosquitos (*e.g.*, *Anopheles maculipennis*), have responded to weak artificial light by showing a readiness to feed and gorge themselves on their avian hosts. This tendency was not displayed by other similar insects maintained at a similar temperature but without the long periods of light. Differences in the fat bodies and in the development of the ovarian tissues accompanied the change in behaviour.

Starlings (*Sturnus vulgaris*) subjected to periods of illumination lengthened by weak electric light (60-watt lamps) responded by an increased activity of the reproductive tissues. Spermogenesis was completed at a time of year usually associated with migration and quiescence of the reproductive organs. Birds activated by the light displayed no tendency to migrate. The male birds proved more responsive to the additional light than the females. It is claimed that additional electric light has increased the yield of eggs of poultry.

Birds and Animals.

Similarly, a modification of the seasonal sexual cycle has been produced in certain small mammals by controlling the period of illumination. Shortening of the daily period of light almost stops the reproduction of the field mouse (*Microtus hirtus*), the female being more susceptible to this treatment. Both male and female ferrets (*Putorus vulgaris*) respond to additional light given in October and January to lengthen the natural period of illumination. Full oestrus was induced in the females; in two months successful coitus took place. In the males stimulation also undoubtedly occurred. The investigators suggest that the mechanism of the response of both birds and mammals may involve the action of hormones of the anterior lobe of the pituitary.

Quite recently reports have appeared in the medical Press of experiments claiming that the follicular hormone may accelerate flower production of hyacinths, lilies of the valley and arum lilies (*Richardia*) when crystallized oestrin was added to the water in which the plants were grown. Further verification of these facts is desirable; but they seem to indicate that the observed parallel responses in animals and plants may both involve the question of hormone activity.

The Environment Factor.

Before concluding, a word of warning is perhaps desirable. Responses somewhat similar to those described above may be produced by other means, *e.g.*, by changes in temperature, by the application of cold to certain localized portions of some plants, or by growing other plants at warmer temperatures. It would also be a serious error to imagine that the "length of day" response is entirely independent of other environmental factors. So closely are the environmental factors interrelated to another in their action upon the organism that great care is always needed in the interpretation of experimental results. In the experiments described the length of day factor has been varied whilst other factors have been held reasonably constant.

The results so briefly reviewed indicate the plasticity of cultivated plants (and of other organisms too); unsuspected responses have been induced by manipulation of an environmental factor; these responses may be of direct practical value in themselves; they lead us to a fuller understanding of the living organism. They also serve to reveal our ignorance of the mechanism operating inside the plant between the reception of the stimulus and the visible response.

In preparing this article the writer has freely drawn upon the work of many investigators. References to the literature concerning plants can be found in "The Annals of Botany, 1925, 1928 and 1933, in the "Journal of the Royal Horticultural Society," 1929, and in the "Annals of Applied Biology," 1932. Concerning certain animals see the "Proceedings of the Royal Society," 1932, for a communication by T. H. Bissonnette.

New Research on Aircraft

By H. E. Wimperis

Director of Scientific Research for the Air Ministry.

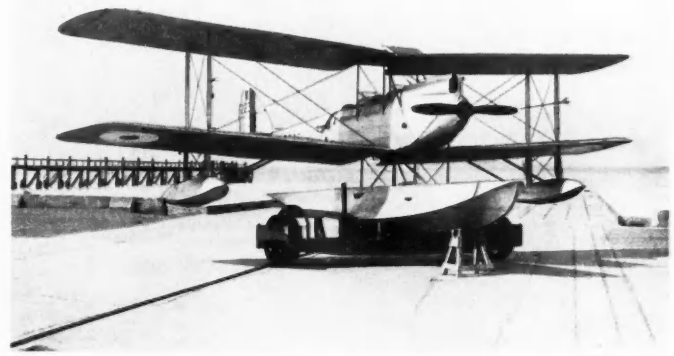
The progress of research on aircraft has recently called for many new instruments. These include the new testing tanks for research on seaplanes, and the vertical wind tunnel for studying "spin" at Farnborough, which is the first of its kind. The latest apparatus was described by Mr. Wimperis in a lecture to the Royal Aeronautical Society.

It was natural when seaplanes first began to be designed that the model testing tanks already in use for the design of the hulls of sea-going craft should be made use of. Testing tanks of some kind were obviously required, and these were the only ones available. It was natural, too, that once such work was undertaken, the testing procedure should follow that which had been in force for many years for purposes of ship design. It does not follow, however, that the procedure best suited to the one would be most suited to the other. It is only at the beginning and end of a flight that the seaplane is in contact with the water, and although these two episodes are exceedingly important, they are of a short duration and involve a rapidly changing speed, ascending when taking-off and descending when landing.

When it was decided to break away from this practice and build a tank specially suited to the needs of seaplane work, the first thing to settle was how large the tank would need to be and at what speed the model should be propelled. Indications of cost required that the tank should be no bigger than circumstances really required, and on this point much diversity of opinion existed. There is a good illustration of this in the recent building for the work of the National Advisory Committee for Aeronautics of the United States of a seaplane testing tank, stated to be capable of speeds of 50 m.p.h. or more, with a cross section of 24 ft. in width by 12 ft. in depth, and no less than 2,000 ft. long. I understand that a similar one, also entirely for seaplane work, is being built in France.

The thought that we have given to the matter in this country has led to quite other conclusions. Our conclusion has been that a tank 9 ft. in width by 4½ ft. in depth and only 650 ft. long would do what was necessary. And it is interesting to note that the new aeronautical tank at Ottawa has a beam, like ours, of 9 ft., a depth of 6 ft., and a length of about 400 ft. It must be remembered, too, that the bigger the tank the greater the cost, the heavier the carriage (ours weighs only some three or four tons) and the longer the time taken in arranging the experiments. We have also to study the question of the speed at which the model is to be towed, for not only is the American tank twenty times the cubic capacity of ours, but in it speeds of 50 miles an hour are contemplated compared with the 40 ft. per second (27 miles an hour) at which we are aiming! Are we being too modest?

To answer this I must explain how we arrive at the speed appropriate to the size of the model to be used. The law of similarity of ships and their models was laid down many years ago by Froude, and it required that the ratio of the speed to the square root of the length should be the same for full-scale and for model. This conclusion was arrived at after a consideration of the loss of energy due to wave making. In the case of a ship this provides the bulk of the resistance, the balance being due to an item for skin friction which is not difficult to compute. In the case of seaplane models the wave making takes up an even larger proportion of the energy and the skin friction effect is negligible, provided that the model is of sufficient length to



MEASURING FORCE ON HULLS.
The Felixstowe experiment in which a Moth fuselage is used to "taxy" a model of a flying boat hull by means of a force-recording undercarriage.

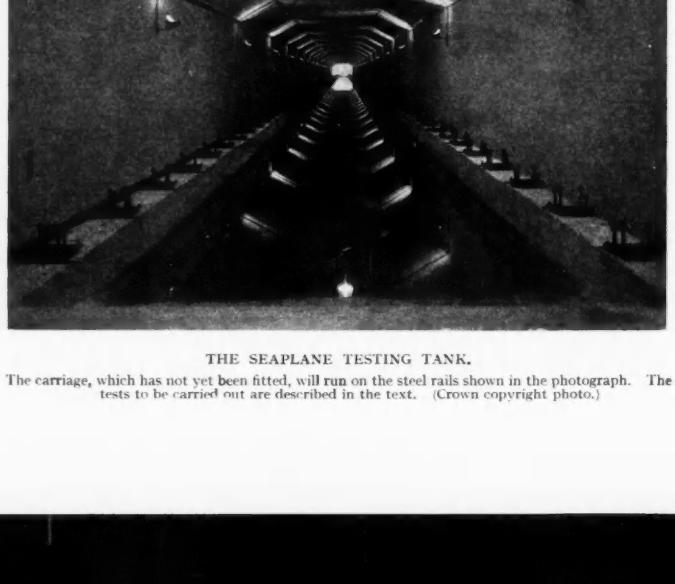
ensure that over the greater part of it the boundary layer is turbulent.

If we suppose that we desire to make measurements on the model of a very large flying boat, say 110 ft. in over-all length, the length at the water line when at rest will be about 80 ft., and a model to a ninth scale would have a length just equal to the width of the tank, namely, 9 ft. If the taking-off speed of the boat were 60 knots, the equivalent speed at which the model must be towed would be 35 ft. per second, or well within the 40 ft. per second which I named above as the full speed of the tank carriage. When much larger models and higher speeds are required for any unusual purpose, we can fall back on an extension of the experiment now being carried out at Felixstowe. Here a Moth fuselage is used to " taxy " a 25 ft. model of a flying boat hull by means of a force-recording undercarriage.

The Farnborough tank and its containing building are now completed, but it has yet to be fitted with its carriage and the measuring apparatus. The carriage will run on steel rails with steel treads to its wheels, but it may later be found advisable to fit rubber treads, particularly if very high adhesive coefficients are required. Careful attention has been given to the programme of work on which the tank will be set as soon as it is ready. The first work will naturally be the carrying out of routine tests on proposed new seaplane designs, following the older methods of test. These routine tests will aim at discovering the chief qualities of the newly-designed hull. These include adequate acceleration at the largest load contemplated, clean running so that the airscrews and tailplane are not damaged, sufficient longitudinal and lateral stability, small impact on landing, and lastly, seaworthiness.

I now come to the newest and, as I think, the most intriguing of all our new research equipment, namely, the new vertical tunnel at Farnborough for the investigation of spinning. Unlike the other equipment this gives such entire freedom to the model that during the whole of the experimentation it is in actual free flight. The practical need for information as to how to design or to modify aircraft so as to be free from dangerous types of spin is urgent. I had long been attracted by the idea of being able to watch the vertical motion of bodies in an ascending current of air, in which the vertical velocity is made just to balance the rate of descent of the model, so that the latter appears at a constant height in the jet. Hence, when the method of dropping models from the roof of the balloon shed at Farnborough had to come to an end by reason of the necessary demolition of the shed, I supported vigorously the construction of a vertical tunnel for spinning work.

The first step was to build a little model tunnel two feet in diameter. This worked admirably. The models showed each of the various types of spin known to exist, and above all they avoided running into the tunnel walls. Steps were then taken to improvise in an existing building a 12 ft. tunnel 30 feet long and having an air speed of 30 ft. per second. This was completed and put to work about a year ago. The models used in it have to be not only geometrically similar, but dynamically similar to the full-sized machine. Hence the dimensions, the mass and the moments of inertia all need to be to the proper scale. The models are made of the very light balsa wood with panels cut out of the wings and covered with thin paper, and ballasted when necessary with lead. It is usual to employ the tunnel not merely to observe the type of spin, but to study the motion which occurs when the controls are suddenly moved over by a delay-action mechanism incorporated in the model.

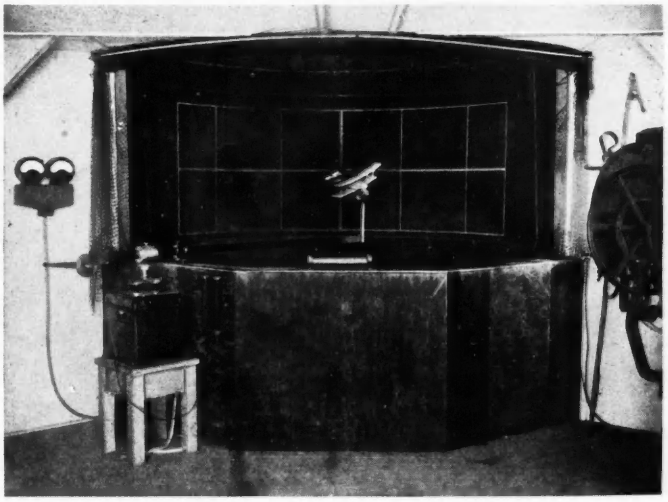


THE SEAPLANE TESTING TANK.

The carriage, which has not yet been fitted, will run on the steel rails shown in the photograph. The tests to be carried out are described in the text. (Crown copyright photo.)

This tunnel is not the first to be built with a vertical axis. There exists at Langley Field, in the United States, a vertical tunnel built specially for spinning investigations, but in it the air

moves downwards instead of upwards, so that free flight is not possible. An immense amount of theoretical work has been done in this country on the motion of a spinning airplane—most of it at the National Physical Laboratory. The motion is, however, excessively complicated and the mathematical work is difficult to apply usefully without preliminary practical tests.



THE VERTICAL "SPINNING" TUNNEL.
The designing of aircraft which is free from dangerous types of spin will be studied by means of this new tunnel, in which the model is in actual free flight. (Crown copyright.)

Since many measurements have to be made on each airplane, it is simpler to put the model straight into the spinning tunnel and let it do the calculations for itself. We have already found that raising the horizontal tail surfaces is of benefit in preventing the fast flat spin from developing. In my own view there is probably no type of spin out of which a skilful pilot could not make recovery to normal flight, given time. But time is just what is not given. In the spin, height is lost rapidly and recovery must be made before it is all lost.

Many other classes of research on aircraft have lately been inaugurated. A very hopeful attack has been made, for instance, on the suppression of aircraft noise. It may, I think, be fairly said that noise is at present the greatest deterrent to air travel. The engine and airscrew are equally responsible. The victims may be the passengers carried or the citizens whose homes lie on the air routes. If the creation of the noise could be suppressed entirely at its very source both would benefit ; if the noise were merely prevented from entering the airplane cabin those on the ground would be no better off, though the passengers would be happier. The aim of research must be the elimination of the noise at its source, but since this is a long and difficult task, it is necessary as an intermediate step to study how to prevent the external noise from penetrating the cabin walls. In this respect a fair measure of success has been attained, and if aircraft constructors would make more use of information now at their disposal, the relative quietness already attained in some aircraft might be achieved in many more.

The first aim in an investigation of this kind is to provide a means of measuring the noise—not in absolute units but on the same sort of scale as that employed by the human ear. It would be of no advantage to the human ear, for example, to suppress all noises under 20 or over 20,000 vibrations per second, because the ear would hear neither, whatever their intensity. Hence the ear must be a part, directly or indirectly, of our measuring apparatus. Such an apparatus is the Barkhausen audiometer. This instrument causes a loud hum, of easily variable intensity, to be heard when a telephone earpiece is put to the ear. The other ear listens to the noise to be measured, and by varying the loudness of the hum from the audiometer a balance of noise can be struck and the scale on the instrument be read off. The scale gives the noise intensity in units known as decibels.

A curious feature of the sense of hearing—as of our other senses—is that a logarithmic scale is employed. A railway carriage has been shown to have a noise of about 70 decibels and an aero engine about 100 decibels. An airscrew having a high tip speed may also reach the 100 decibel level given for the aero engine. It might be thought that with both engine and airscrew at work the resulting noise must add up to 200 decibels, but this is not so. On the logarithmic scale 100 added to 100 yields not 200 but 103. Since a noise of 100 decibels added to another of the same intensity give a combined noise level of 103 decibels, it follows that with two such noises present it is almost useless to suppress one only—that merely reduces the noise from 103 to 100.

Experience shows that by reducing the tip speed of the airscrew to some value not exceeding 600 ft. per second, the noise level can be reduced to 60 or 70 decibels. It is not easy to reduce the engine noise to the same degree, partly because the engine clatter

is nearly as bad as the engine exhaust, whilst for the reasons already given it is of little service to reduce the one without the other. However, progress is being made, though I fear it must be slow. It is fortunate for the passengers, however, that the noise in the cabin can be reduced by 20 decibels or more by the efficient lagging of the walls and general care in layout of exhaust pipes in relation to wings. Care in all these directions has shown that it is possible to make the cabin of an aircraft no noiser than an ordinary railway carriage, so that conversation at an ordinary tone of voice is easily possible. This excellent result has, for example, been attained in the class of flying boat used on the Mediterranean service and in the new machines on the Paris service. It is much to be hoped that other aircraft builders will follow this excellent example ; and certainly there is no reason why the public should not now demand a really high standard in this regard.

And if I am asked, " To what great end is all this activity directed ? " what is to be my reply ? Can I truthfully say that it is imperatively bound to add to human happiness ? I fear not. The provision by scientific research of increased power over nature produces greater happiness if, and only if, it is wisely employed. The world gathers knowledge faster than wisdom. The problem is frankly faced by Professor Julian Huxley in his book, " What Dare I Think ? " He says : " I do not share the facile optimism which sees in every increase of power, every fulfilment of a wish, a necessary good. The knowledge provided by science is emotionally and morally neutral. And so is the power of control which inevitably arises out of that knowledge. It is a tool which, like other tools, can be used for whatever ends its possessor sees fit, whether good, bad, or indifferent."

The Time-Scale of Evolution.

THE effect of the expanding universe on the " time-scale " of evolution is discussed by Sir Arthur Eddington in his latest book.* Three different time-scales have been favoured at various times—short, intermediate and long. Naturally, it is the policy of the evolutionist, writes Sir Arthur, to grab as much time as possible in order to give his processes a longer opportunity to accomplish something. So when there is no strong evidence either way, the longer time-scale gets the preference. This, rather than any striking success of the theory, accounts for the popularity of the long time-scale in recent years : " Like other time-grabbers I have generally adhered to the long time-scale provisionally since it affords more time for investigation. But two years ago I was much shaken by a study of the dynamics of our Milky Way system ; its form and construction seem to be such that it is impossible that it should have endured for the period of the long time-scale."

The author points out that in a universe doubling its radius every 1,300 million years, the long time-scale of billions of years is altogether incongruous. It is true that the theory of the expanding universe does not set any limit to past time. There may have been a very long period of approximate equilibrium before any serious expansion took place ; but this scarcely counts from the point of view of stellar evolution. Astronomical history, Sir Arthur writes, may be said to begin when the first condensations were fully formed and the galaxies separated from one another ; but by this time the expansion must have been well under way. It is difficult to allow more than 10^{10} years between then and now. Thus " astronomers who have been luxuriating in an enormously long time-scale are threatened with a drastic cut."

If, the author says, we find it hard to accept the speed at which the universe is changing, acceptance is not made easier by the consideration of what it is changing towards. The fragments of the " burst bubble " will continually become more numerous until each galaxy is a separate fragment. The assumption is that the distance of one galaxy from another will ultimately become so great, and the mutual recession so rapid that neither light nor any other causal influence can pass from one to another. All connexions between the galaxies will be broken ; each will be a self-contained universe uninfluenced by anything outside it. " Such a disintegration is rather a nightmare to conceive, though it does not threaten any particular disaster to human destiny."

It appears then, Sir Arthur concludes, that the " bursting of the bubble " will end when each galaxy is a separate fragment ; it will not go on to disrupt the galaxies. These no doubt contain their own seeds of decay and cosmical repulsion may ultimately help to scatter their fragments ; but that concerns a much more distant future : " If you think that the shattering of the bubble universe is a tragic outlook, it may be some consolation to reflect that when the worst has happened, our galaxy of about a hundred thousand million stars will be left intact."

* *The Expanding Universe.* (Cambridge University Press 3*s.* 6*d.*).

The Progress of Medicine—III.

Ten Years' Research on Anaemia.

By Antionette Pirie.

Bio-chemical Laboratory, University of Cambridge.

Anaemia is not as common a complaint to-day as it was thirty years ago but the disease still exists in several forms. The author here reviews the rapid advances made in this branch of medical research during the past ten years, and describes some of the experiments carried out on human beings as well as animals.

ANAEMIA is a term loosely used by both doctors and the public to denote a weak state of health. It includes many of those cases of illness, particularly occurring in growing children and young adults, where no definite cause of the ill-health can be found. Rest, change of diet, exercise, iron tonics, and sea air have all been prescribed for such a condition and one or other of the treatments is usually successful. Each case of this sort must be considered individually for it is a condition which has a variety of causes and therefore a variety of treatments. More serious anaemias, where a noticeable change has taken place in the blood, have been more definitely classified.

They may first be divided into two classes, those due to excessive blood destruction and those due to insufficient blood formation. The first is the cause of the anaemias of acute infections such as gas gangrene, blackwater fever, Oroya fever, some streptococcal infections and of rare anaemias occurring in pregnancy and new-born infants. I do not propose in this article to discuss this type of anaemia as it is far rarer and less is known about it than about the anaemias due to insufficient blood formation. Chlorosis and pernicious anaemia may be taken as important and typical members of this second class of anaemia.

The Red Blood Pigment.

In chlorosis the most noticeable sign is a general pallor due to deficiency of the red blood pigment Haemoglobin (the disease earned the name of green sickness from this characteristic). It was prevalent among young employed women such as shop assistants and domestic servants about thirty years ago and made a large proportion of them chronically unhealthy. At the present time this anaemia has vanished, probably owing to the achievement by working women of higher wages and better habits of exercise and dress. Pernicious anaemia, or as it is more generally known, Addisonian anaemia, was first described by Addison, a physician at Guy's, in 1856. The chief deficiency of the blood in this disease is in the number of red corpuscles which may be reduced to one fifth of the normal. It was invariably fatal until a successful treatment was discovered six years ago, and at the present time it is said that research is being held up because of a shortage of patients.

Many Factors.

Many different factors are involved in blood formation and if any one of these is deficient, anaemia of one type or another will develop. The microscopical change in the blood picture is a sign in each case of some disorder in the chain of blood formation, and varies according to which link has been affected. Anaemias are classified by the change that has taken place in the blood, and treatment is based mainly on this examination. Normally the blood contains 5,000,000 red corpuscles per cubic millimetre. These red corpuscles are very small bi-concave cells without a nucleus and contain one third of their weight of the iron containing respiratory pigment Haemoglobin. This pigment forms a loose compound with oxygen and is the means of transporting oxygen from the air in the lungs to the remote organs of the body. Thus if there is any deficiency in the number of red corpuscles or in the amount of Haemoglobin which each contains, the whole body will suffer from partial asphyxiation.

In the adult animal the red corpuscles are made in the red marrow of the long bones. The marrow consists of a network of capillaries, or very small blood vessels, some of which are lined by special cells which are the precursors of the red corpuscles. These cells first become detached from the capillary wall and are then termed megalocytes. They then become round in shape, develop Haemoglobin inside themselves and finally lose their nuclei. At this final stage the red cells contain granules of deeply staining material although they have no definite nucleus. They are now called reticulocytes, and the number of this type of cell in the blood is used as an indication of the amount of blood formation that is going on in the marrow; for if a great deal is being formed then more of these immature cells will appear in the blood than if there is only slight blood formation and no congestion in the marrow.

Once a corpuscle is free in the blood stream it does not continue circulating indefinitely but just like other cells of the body it wears out and has to be replaced.

Anyone who has seen a microscopical preparation of the blood streaming through a capillary bed will realise what a jostling and bumping the cells experience. The worn out corpuscles are removed from the blood by the spleen and their Haemoglobin is broken down into simpler compounds, some of which are excreted in the bile. The iron from the blood Haemoglobin is stored in the liver and can be used again for further production of the pigment.

Limitations of Research.

Research on the etiology and cure of the different forms of anaemia is limited by the fact that under natural conditions man is the only sufferer. In spite of this fact, however, the successful treatment for pernicious anaemia was indicated from the researches of Whipple and his co-workers in America on induced anaemia in dogs. A patient suffering from pernicious anaemia has in his blood only one fifth to one half the normal number of red corpuscles. Some of these are immature cells which have been extruded from the bone marrow while still retaining their nuclei ; before their development was complete. It has also been found that pernicious anaemia patients have a faulty gastric secretion. Usually their stomach juice contains no free hydrochloric acid and sometimes also none of the digestive enzyme Pepsin. Yet although it was felt that this digestive disturbance might have some connexion with the diease of the blood, no beneficial effect was regularly obtained by any one particular diet.

Whipple found that if dogs were subjected to repeated haemorrhages and kept on a diet which consisted mainly of biscuit, they became after some months truly anaemic and were unable to regenerate the corpuscles lost by bleeding. If liver or kidney were added to their food, however, the number of corpuscles in their blood increased rapidly and they were cured of their anaemia. Iron salts also caused an increase in blood cell formation, but, since the iron contained in a certain amount of liver was only half as effective as the liver itself, Whipple concluded that liver contained something other than iron which was a stimulus for blood formation. Of all the different substances that he tested on his dogs, liver, kidney and iron were by far the most effective in causing rapid formation of red corpuscles in the blood.

In Boston Minot and Murphy then fed a large number of pernicious anaemia patients with liver. They found that if the patients ate about half a pound of raw or cooked liver every day they were rapidly cured. The number of the red corpuscles in their blood increased after a week of treatment. At first there was a great increase of reticulocytes in the blood owing to the fact that the bone marrow was being stimulated so much that many cells entered the blood stream before they were mature. But after three weeks of treatment the number of reticulocytes decreased again and their place was taken by normal corpuscles. This " reticulocyte crisis " was used as a means of testing the response of a patient to treatment, since an increase in the number of reticulocytes could be estimated before any change in the total number of red corpuscles was noticeable. Minot and his co-workers found that all patients with pernicious anaemia responded to this treatment, and that their blood remained normal for so long as they continued to eat liver, but that if liver was discontinued anaemia would again ensue.

The cure of this hitherto fatal disease was a remarkable triumph for experimental medicine and carried the search for the cause of the disease one step further forward. The next advance was made by Castle, who connected the disturbance in the gastric secretion of pernicious anaemia patients with the blood deficiency.

It was known that of the few people who had survived the removal of a large part of their stomach, some had developed pernicious anaemia, and it was also known that if a patient began to secrete a normal gastric juice he cured himself of his pernicious anaemia. It occurred to Castle that, in the process of digestion in a normal stomach, some substance was produced that had the property of stimulating blood formation, and that this substance was stored in the liver. In pernicious anaemia the digestion was at fault and the blood stimulator was not produced.

Studying Digestion.

The results of his experiments confirmed this view entirely. Castle obtained some gastric juice from a normal man and incubated it with raw minced beef at body temperature for several hours. He then gave this mixture, instead of liver, daily to patients with pernicious anaemia. Other patients received either normal gastric juice alone or raw beef alone. It was found that only those patients who received the incubated mixture of beef and gastric juice recovered from their anaemia. The response in these patients was as great as that obtained by liver feeding.

It was therefore established by this work, using patients themselves as experimental material, that liver, or meat pre-digested with normal gastric juice, added to the diet will cause a great increase in the number of red corpuscles in the blood, and that the number will remain high for as long as the correct

diet is taken. The theory put forward by Castle that the fundamental cause of pernicious anaemia is the lack of some factor in the stomach juice has been generally accepted. This factor cannot cure pernicious anaemia by itself, nor can a beef diet do so, but a mixture of the two is as effective as liver alone. It is probable that the stomach factor is an enzyme like Pepsin, which breaks down the large molecules in the meat protein and liberates a substance which stimulates blood formation. This substance is thought to be the same as the liver factor.

Neither of the two factors has yet been obtained in a pure state. The stomach factor is very unstable and is destroyed if it is heated much above body temperature, so that its isolation will be very difficult. Much greater success has been attained with the liver factor as this is a stable compound which can withstand boiling and such rough treatment. This substance has been proved to be a fairly simple compound. It has been separated from the proteins and fats of the liver without any loss in potency but has not yet been obtained in a pure state. As each fraction of the liver has to be tested on a patient with pernicious anaemia in order to find out if it contains the active substance or not, the research is necessarily very slow.

In pernicious anaemia it often occurs that a gradual paralysis sets in, and examination after death shows that this is due to changes in the spinal cord. In some cases the paralytic symptoms do not improve with liver treatment in spite of the fact that the blood corpuscles return to normal. Lately it has been reported that a very great improvement can be obtained by the daily administration of large doses of iron salts. This action of iron is peculiar in that it seems to be quite apart from any effect on the blood. Since the blood pigment Haemoglobin contains iron, a certain amount must always be present in the body, but in pernicious anaemia, liver treatment alone is able to restore the Haemoglobin to its normal level and extra iron does not have any effect on this, although it does relieve the paralysis.

Faulty Diet.

It is interesting to realize that although pernicious anaemia is caused by an unavoidable body defect—the lack of an enzyme-like substance in the secretion of the stomach—many people suffer from entirely preventable anaemias due to a faulty diet. Chlorosis, or the green sickness, which used to attack young women has already been mentioned. This was a dietetic anaemia which has disappeared owing to improvements in general conditions of life. But in the tropical countries, such as India, there is still a great deal of anaemia which is thought to be due to malnutrition. In some classes of people in India the number of red corpuscles in the blood is directly proportional to the level of food intake. Serious anaemia is most common in pregnant women and there is a high death rate in untreated cases.

This anaemia is not of the same sort as pernicious anaemia but it does repond to liver treatment and also to Marmite feeding. Marmite is a commercial preparation made from yeast and is a rich source of the vitamin B complex. It is not known whether its curative action is due to the presence of these vitamins which are also contained in fresh liver. Anaemia also occurs in pellagra, which is a disease having vitamin lack as one of its causes. Many people suffer from pellagra in the rice-growing areas of the world although it is preventable by yeast feeding.

Anaemia in Infants.

A less serious nutritional anaemia occurs in milk-fed infants during the first year of life, due to a lack of mineral elements in the milk. The blood Haemoglobin reaches a normal level spontaneously after the infant is given a mixed diet or if iron salts are added to the milk.

Breast-fed babies are nearly as prone to this disease as are the artificially fed children, and its importance seems to lie in the fact that anaemic babies are twice as liable to develop other complaints, such as colds and intestinal disturbances as are the iron treated ones.

Severe milk anaemia which may prove fatal can be produced in young rats if they are weaned from their mother as soon as possible and fed solely on cow's milk. In this case carefully purified iron salts added to the diet have no curative effect, but a minute trace of copper clears up the anaemia quite rapidly. This is a very remarkable effect for copper to have, since it is not known to be a constitutent of blood corpuscles. Recently some interesting experiments have been carried out which show that iron cannot be utilized by the young rat in forming Haemoglobin unless copper is present also. Young rats were made anaemic by a milk diet and then were given a daily dose of iron salts for a fortnight. At the end of that time some of them were killed and the iron content of their liver and blood was determined. The rest of the rats were then divided into two groups, one of which received no treatment while the other received a daily dose of copper salts. After another fortnight the rats were all killed and analysed.

It was found that in those rats which had received

iron salts the liver iron content had remained high and the blood Haemoglobin was low, whereas in those rats which had received iron followed by copper the liver iron content had fallen but the blood Haemoglobin had increased considerably. It therefore seems that copper stimulates the production of Haemoglobin from iron which is already present in the rats' liver. This work has not been linked up with any human anaemia, but the possibility that part at least of the curative action of large doses of iron is due to the copper that is contained in them has not yet been ruled out.

The object of this brief survey of some of the types of anaemia has been to show what rapid advances have been made in their treatment and understanding during the last ten years. Experimental work on a disease which only occurs naturally in the human race is particularly difficult, and it is interesting that, although the action of liver in pernicious anaemia was primarily investigated because it had been shown to cure the induced anaemia in dogs, it was later found that fractions of liver that were active in curing pernicious anaemia were of no value in the experimental dog condition. Animal experiments have also shown that copper is important in blood formation, and although this work has not yet been linked up with any human anaemia, it seems most probable that the same processes are involved. Since blood formation requires the presence of so many different factors it is not remarkable that breakdowns often occur.

Chlorosis disappeared from England without any conscious organized effort being directed towards this end, but simply because of a rise in the material well-being of the working woman. It is to be hoped that, since the anaemias which are due to under-nutrition, vitamin deficiency or mineral deficiency have been investigated and in many cases satisfactory preventatives and cures found for them, these anaemias will also soon cease to be a cause of ill-health and avoidable waste throughout the world.

Attacking the Tsetse Fly.

The Need for Research.

THE gravity of the tsetse fly menace in many parts of Africa is emphasized in a report just issued by the Tsetse Fly Committee of the Economic Advisory Council. The report states that over large stretches of territory no economic progress will be possible until this problem has been successfully tackled, and even in areas that are at present settled there is often a danger that an advance of fly may take a heavy toll both of human life and of the livestock on which the native largely depends for his existence. In extreme cases there may in present conditions be no alternative to the evacuation of the population and the surrender of territory to the fly.

Research for improved methods of tsetse control, far from being of academic or scientific interest only, is thus a problem of great urgency and practical importance to many of the Colonial Administrations in Africa.

Past experience shows that there is no royal road to the elimination of tsetse flies. The measures required differ according to each kind of tsetse, and even for the same kind of fly it is often necessary in different districts to apply different methods, on account of differences in the type or habits of the natives inhabiting them or the character of the terrain.

The measures which are being adopted include the destruction of fly-infested bush by clearing or by fire; the erection of natural barriers to isolate the fly and infected game; and the wholesale catching of flies by hand or by specially made traps. By various methods considerable areas of land have been made available for occupation.

The most important work has been that carried out by the Tsetse Research Department of the Tanganyika Territory. This has brought within measurable distance the practical solution of many aspects of the tsetse problem. It is thus in the truest sense of the term pioneer work of the utmost value to every country where tsetse flies occur. The Committee trust that, notwithstanding the present financial stringency, every effort will be made in this and following years to provide the funds necessary for the continuance of this work, the successful conclusion of which is vital not only to Tanganyika, some two-thirds of the area of which is under fly, but also to other fly-infested territories in Africa.

The Committee look forward to the time when it will be possible in suitable areas to eradicate tsetse flies at a relatively small cost without risk of producing undesirable results in other directions. Such work will, however, always require special technical knowledge, and in countries in which wide areas are in the grip of the fly, reclamation will only be successfully conducted if there is maintained a small organization staffed with men specially trained for the purpose.

The Progress of the "Polar Year."

In the Arctic regions the past year has seen the inauguration of a remarkable effort in international co-operation. The "Polar Year" has now been in progress for some months, and the work of the various expeditions engaged is reviewed in the "Polar Record." The following extracts deal with research which is of general interest.

THE Polar Year for the investigation of meteorology and allied sciences in the Arctic has run half its course. In spite of the universal financial stringency and the consequent slenderness of official resources, an imposing number of expeditions is now at work. The preliminary plans were reviewed by Professor Frank Debenham in *Discovery* for January, 1932. When all the results are collected and analysed, they are likely to have far-reaching effects on daily life. Their effect on wireless transmission and air transport will possibly carry a more direct appeal to the layman than the origins of "depressions over Iceland," but other and possibly more useful results may arise from this concerted attack upon the air and its ways.

The British Expedition, which is spending a year at Fort Rae on the Great Slave Lake, provides an example of the routine which most of the Polar Year stations will probably be following. On arrival at Fort Rae they at once set up the station. Several log-huts were available, both for living accommodation and scientific purposes, though much had to be done to these before they are actually ready for use. Old Fort Rae, which is 17 miles from the present settlement and was the site of the British Polar Year station in 1882, was visited soon after the arrival of the party, and plans made for laying a cable in order to connect the two bases by telephone for auroral photographic work. This was found to be impracticable until the lake should freeze, on account of the deeply indented shore-line. Meanwhile, parties of two have been taking duty at the Old Fort at regular intervals, reaching it by motor boat, a rather hazardous proceeding, owing to the frequency of high winds and the rocky and shallow nature of that arm of the lake.

A Hundred Degrees of Frost.

At first the party experienced uncomfortably high temperatures, but later news tells of a steady fall in temperature, with the consequent disappearance of mosquitoes, etc. Fort Rae is one of the coldest places in the world, and 100-110 degrees of frost may be experienced in the winter. It was announced in the last report received from the party that they were expecting the lake to freeze any day, Great Bear Lake, 200 miles farther north, having already frozen over.

It had previously been hoped that a dog team, to be used as a means of transport after the freeze up, might be purchased at Fort Rae, but on arriving there it was found that suitable dogs were not easily obtained. A journey was therefore made by motor-boat to Fort Resolution on the south side of the lake, a somewhat dangerous undertaking owing to severe storms encountered both on the way there and on the return; dogs from Hay River, a settlement west of Fort Resolution, were bought and were transported to Fort Rae by boat.

Studying Auroral Displays.

The instruments have been found to be satisfactory, and most of them have been recording since the beginning of July, 1932. It is doubtful, however, if many of the meteorographs which have been sent up frequently by balloon are likely to be found, as the country round Rae consists almost entirely of a labyrinth of muskeg swamp. The Indians, however, have been told to bring in any they may find. All other work is reported to be proceeding according to plan.

At first attention of the party was concentrated chiefly on the auroral displays. They are photographed simultaneously at the Old and New Forts, and observations are made from 11 p.m. to 2 or 3 a.m. every night. A routine has been evolved for these observations, by which the control photographer at the main base has a local telephone line into the nearby hut. A couple of transformers (borrowed from the wireless receiving sets) are used in the telephone line, and the microphone is arranged to actuate two telephones, one for the "recorder" responsible for noting all the details sent in, the other for a third man in charge of the transmitting set; the latter repeats immediately into the transmitter microphone all the instructions for exposure of plates; he also ensures during every short lull that all is going well at the other end of the base. The other two of the five men engaged in this procedure are at the sub-station at Old Fort Rae, the one outside manipulating the camera, the other inside the hut attending to the receiver and transmitter; there is no need for a recorder at the sub-station, as all the details are noted at the main station.

Other work at Fort Rae includes pilot balloon ascents, which are being made daily. Meteorological observations have been made every three hours since

July 31, and reports are being sent daily to Toronto. Terrestrial magnetism is also receiving attention, and full records have been secured since the beginning of August. Regular observations are also being made in atmospheric electricity.

Work in Canada.

The Polar Year stations in Canada have been planned with a view to providing a chain of observation posts, from 600 to 900 miles apart, connecting stations in Greenland with the United States station at Fairbanks, Alaska. Three expeditions have therefore been sent out: to Cape Hope's Advance, in Hudson Straits, about 600 miles from the nearest station in Greenland; to Chesterfield Inlet, on the west coast of Hudson Bay, 750 miles distant; and to Coppermine, on Coronation Gulf, 800 miles to the west, and just over 900 miles from Fairbanks. The regular meteorological stations in northern Canada are also making special observations. As all these stations, expeditionary and otherwise, are equipped with wireless, they have remained in communication with the outside world.

The auroral programme provides for two sub-stations, about 18 miles apart, connected by radio, to measure the height of the aurora, and there is also a night spectrograph to obtain photographs of the visible and infra-red portions of the spectrum. A complete log will be kept of auroral phenomena, and the approximate intensity measurements with a pocket spectroscope. The meteorological programme includes full surface meteorological observations, pilot balloon ascents twice daily, kite flights as weather permits, and visual signalling meteorograph ascents on international days. A continuous record is being kept of the difference in temperature between the surface, and the top of the radio mast nearly 150 feet above, special thermocouples being used. The temperature of the air at the 4 foot level is also being taken, and radiation measurements made. Cloud observations are being carried out according to the programme of the International Cloud Commission. January and February are the coldest months, the temperature averaging 26° or 27° F. below zero and the lowest temperature recorded at Chesterfield Inlet has been 55° F. below zero.

A British expedition, directed by Professor E. V. Appleton, is spending a year at Tromsö making special wireless investigations on behalf of the International Scientific Radio Union, and the British Polar Year Committee. At Tromsö, where there is an extended base with both power and telephone circuits, it is hoped to find conditions where the effect of the ultra-violet rays will be at a minimum owing to the high latitude, and where, being within the auroral zone, it may also be possible to make a detailed study of the influence of aurora on wireless transmission.

Special methods are being used for measuring the concentration of electricity in the Kennelly-Heaviside layer, and measurements will also be made of the upper atmospheric electricity, and ionized layers. Routine observations on signals from long and short wave stations in America and Europe will be made by the wireless operators. As a result of these and other investigations it is hoped to establish a radio route through the ether 130 miles above the North Pole, in the Appleton layer, discovered by Professor Appleton, which has been found to be the best region for transmission of wireless messages over great distances. This route is much the quickest of any known, but up to the present time has given less satisfactory results than those passing through more temperate regions.

An important branch of the work carried out by the Danish three-year expedition to East Greenland has been a survey from the air, the aeroplanes having flown over 24,000 miles while engaged on this task. The object of these flights was to investigate hitherto unknown parts of the ice-cap, to carry out extensive mapping of the ice-free coastal districts, and to explore the eastern coast from the air. During these flights it was discovered that the western slopes of the East Greenland mountain belt, where the expedition expected to find large ice-free areas, were covered with snow, with only a few isolated rocks visible. It was also found that the land between the ice-cap and the coast was much narrower than had been expected. Observations were also made on the grazing grounds of musk-oxen, which proved to be much less extensive in this region than had been previously supposed.

An Important Discovery.

An important result of the expedition was the finding of about 5,000 fossils of lepidosirens and sclerodermi in Franz Josef Fjord, a discovery which may be of great value in providing the necessary link between two stages in evolution. The fossils were discovered in a bay where some catastrophe, killing the animals in vast numbers, had apparently occurred in prehistoric times.

Work in connexion with the International Polar Year is being carried out on a large scale by the U.S.S.R., a network of stations having been established over the country at which meteorological observations and investigations into atmospheric electricity, the tides and hydro-chemical bacteriology are being made. A complete meteorological survey of the whole Soviet Union is also being carried out. Work has been

THE BRITISH STATION AT FORT RAE.

The cross in the photograph marks the rocky island occupied by the British Polar Year Expedition. (Royal Canadian Air Force photo.)

in progress since the beginning of August at all the seventy-six stations, of which twenty-nine are newly established.

One of the most important of these stations is situated in the Russian Harbour district of the west coast of Novaya Zemlya, with a sub-station on the ice-cap, where a radio telephone has been installed. The lower station is equipped with a long-wave transmitter, by means of which it is hoped to keep in constant communication with the stations at Matochkin Strait and Cape Zhelaniya. Dog transport will be used, and the stations are also supplied with an aeroplane. Glaciological observations will be made at the ice-cap station, including measurements of the thickness of the ice by seismic methods similar to those used on the Greenland Expedition. A botanical survey will be made at the lower station.

A comprehensive programme of work has been arranged by the United States, the last Congress having voted $30,000 to assist towards American participation in the International scheme. Most of the work is planned to take place in Alaska, and three important stations are now functioning at Point Barrow, at Nome, and at Fairbanks. The programme includes pilot balloon ascents twice daily, magnetic work, and complete surface meteorological observations. Photographic records of aurora are being made simultaneously at Point Barrow, Fairbanks and Nome; communication between these stations being made possible through the U.S. Signal Corps Radio. The magnetic observations are being carried out in co-operation with the Department of Terrestrial Magnetism, the Carnegie Institution of Washington, and the U.S. Naval Research Laboratory.

At Fairbanks, aeroplane observations take place and it is expected that these flights will average about three miles in height. It is also hoped to make a few observations at greater heights with radio meteorographs, and thus obtain valuable information as to the seasonal variation in the height of the tropopause, and in the temperature of the stratosphere in this region. A five-year plan of auroral work has been made possible by a grant from the Rockefeller Foundation.

Auroral observations, to be entered on star maps, are being carried out at nine selected stations close to the northern border of the United States, and in Alaska. Spectroscopes for detecting the presence of aurora during twilight or moonlight or when the sky is overcast, have been installed at these stations. Observations of nacreous clouds, and at the Alaskan stations, of the blueness of the sky, are taking place at the same time.

Special forms for auroral observations have also been given to ships following routes in high latitudes, and it is expected that from thirty to forty vessels will assist in this way, a large proportion of them in Alaskan waters.

An interesting achievement, which is not connected with the Polar Year but is reported in the *Polar Record*, may here be mentioned. A large herd of 3,000 reindeer, which had been consigned to the Canadian Government and is to be handed over when it has crossed the Mackenzie River, has been driven across the tundra by a party of drivers. The journey has already taken three years.

Developments in Infra-red Photography.

By Olaf F. Bloch.

President of the Royal Photographic Society.

The discoveries of the organic chemists have now yielded a number of dyestuffs capable of making a photographic emulsion responsive to the infra-red region of the spectrum. The latest development is a new photographic dye discovered by Ilford, Ltd., which permits the preparation of infra-red emulsions at very high speeds.

THE preparation of photographic material of far higher speed in the infra-red region of the spectrum than was hitherto possible is responsible for the great revival of interest in the subject and the widening of its practical applications. Work which before was not practicable on account of the prolonged exposures involved, now becomes comparatively easy. Daylight contains ample infra-red light for photographic purposes, especially when the sun is shining, and all high temperature artificial light sources contain more or less, varying with the temperature of the emitter. A convenient source is the ordinary gas-filled electric lamp. It is necessary to use a light filter in conjunction with the lens, which absorbs all the visible light and transmits infra-red light only.

With artificial illumination an alternative method may be followed, the illuminant itself being enclosed in a lamp house which is glazed with a filter of the same type as that used in the camera. If high power illuminants are used, the heat becomes very great, and it has been found advisable to install a small fan blowing a current of air through the lamp houses if these are to be kept running for any length of time. Dyestuffs in general do not possess sharply bounded absorption bands; in consequence, attempts to restrict still further the red transmission by increasing the dye concentration, would so greatly increase the absorption of the infra-red itself that exposures would be unduly prolonged when such a light filter was employed. The exposure depends, as with all other photographic material, on the intensity of the illuminant, the character of the objects to be photographed, their distance from the camera, and so forth.

A VIEW WITH AN ORDINARY PLATE.

This photograph of Canterbury Cathedral was taken on a misty day. The cathedral is scarcely visible and the background is enveloped in mist. (Ilford photo.)

A certain number of dyes when in solution transmit infra-red light freely, as does also a solution of iodine in carbon disulphide, certain glasses containing oxides of iron and manganese, etc., and these can serve as light filters. Lenses do not all behave alike in their covering power, or in the distance of the image plane from the nodal point. Recently two English firms have placed upon the market lenses which cover well and whose infra-red and visual foci are alike. As most infra-red plates possess very feeble green sensitivity, a fairly bright yellow-green safelight containing a substance which absorbs the infra-red can be employed, and handling and processing are thus rendered easy.

The air is seldom really clear in England because a considerable amount of water vapour is usually present; consequently, long distance vision is rare. It is well known that the shorter wave-lengths comprising the blue and violet constituents of light are more readily scattered by small particles than the longer wave-lengths constituting red light, and infra-red light is scattered even less. This principle has been adopted in the orange and yellow filters employed for motor-car headlights, but it is doubtful if these are generally sufficiently red to be of great practical value. The use of infra-red photographic material thus enables one to employ a greater proportion of the direct image-bearing light, and it becomes possible to take distance photographs in hazy weather and even to secure images of objects which are invisible to the eye because they are lost in the prevailing haze or mist. One of the earliest of these photographs was taken by Dr. Wright of the Lick Observatory, and shows the Sierra Nevada mountains at a distance

of 150 miles. More recently, an aerial photograph has been taken from a height of 23,000 feet in what must have been an extremely clear atmosphere, showing Mount Shasta, at a distance of no less than 331 miles. Another photograph taken from the air shows the haze of the pampas against the Andes Mountains at a distance of 310 miles in such a way as to demonstrate the earth's curvature. There is yet no exact information about the effect of varying atmospheric conditions on this class of work. Fuller knowledge is necessary regarding the action of variation of the dimensions of the water particles which constitute mist or haze, and also in what direction the additional presence of carbon particles constituting fog modifies the transmission of infra-red light.

THE SAME VIEW WITH AN INFRA-RED FILTER.

An identical view with that on the previous page, taken immediately afterwards with the use of an Ilford infra-red filter. The detail in the background is clearly seen.

The method has found some application in Press photography, a notable instance being the photograph of the Cenotaph taken on Armistice Day which appeared in several newspapers. The weather was foggy, but the infra-red photographs are remarkably clear, giving a view up Whitehall to Trafalgar Square with an almost complete absence of mist. Little is known about the infra-red content of daylight, but it has been found that the time necessary to secure correct exposures can vary without any change which can be appreciated by the eye. Dr. G. B. Harrison has made photo-electric cell records of the visible and infra-red content of daylight taken simultaneously during three days. These were made by means of two cells, one of which gives approximately visual daylight response, whilst the other possesses high infra-red sensitivity; the cell aperture of the latter was covered with an infra-red filter. The galvanometer mirror movements are recorded on two revolving drums covered with sensitive paper. Whilst an increase in the amount of visible daylight is sometimes accompanied by increased infra-red content, at other times there is no proportionality between the two.

Aerial photography presents a useful field for work, as was shown by Major Hemming in *Discovery* last month. Though the photographic material at present available is somewhat slow, interesting results have been obtained under favourable conditions. The combined study of photographs taken on ordinary or panchromatic plates and those taken on infra-red plates promises to be serviceable since each photograph reveals details which are lacking on the other. It is well known that when foliage is photographed by the infra-red process it is always rendered darker in the negative and lighter in the print than is normal. Indeed, when the sun is shining it photographs so dark that the prints have somewhat the appearance of a snow scene in winter. This is because chlorophyll both reflects and transmits, but does not absorb, that portion of the infra-red light to which the plates used are sensitive, and it seems reasonable to suppose that it rejects this radiation because absorption of it would not be beneficial to the foliage. Flowers and fruit exhibit the same phenomenon and probably for the same reasons.

The treatment of fabrics with dyestuffs can produce big differences in their behaviour to infra-red light. Some coloured fabrics, though dyed with dark or black dyestuffs, reflect infra-red light strongly and might be cooler to wear in warm weather than those dyed fabrics which absorb it, but we have no proof of this. Little appears to be known about this and the effect of variations in the method of dyeing, in the mordants used, or in the after-treatment of the dyed material, has yet to be investigated. The after-treatment is certainly of importance. Two samples of cotton were dyed with chlorazol steel blue and one was afterwards treated with copper sulphate and potassium bichromate. In the same way, after-treatment with formaldehyde can produce marked changes. The former shows slight and the latter very strong infra-red absorption. In such cases the photographic method of differentiation might conceivably be an aid to analysis and classification.

In the study of documents the usual method in dealing with erasures, blacking out, over-writing and supposed forgeries is the photography of these in ultra-violet light. Recently, the infra-red method has been applied with success in certain cases.

Bendikson, in 1932, photographed pages from a copy of Theodore de Bry's "Voyages" which is in the Huntington Library; these pages had been obliterated in black ink by the Inquisition Censor 300 years ago. The results show that the defacing ink is sufficiently transparent to infra-red radiation to permit of the successful photography of the underlying invisible printing. Many factors may affect the result. The character of the paper or parchment, the composition of the original ink used, the composition of the ink employed for erasure or over-writing, and the nature of the faded inks, which, in turn, depend upon their original composition. If the fluorescence of the paper or the ink in ultra-violet light are of the same order, and if their reflective and absorptive properties in infra-red light are also alike in degree, no useful results can be expected.

A Portrait in the Dark.

The taking of a photographic portrait in apparent darkness proved somewhat of a sensation, and it was the examination of these pictures that directed attention to the notable differences in the variously dyed clothing. In general, infra-red portraits are far from flattering. In some cases they reveal hair beneath the skin of clean-shaven males, probably owing to pigmentation differences; in other cases the entire features of the sitter appear to be modified, never to advantage. In one instance of a photograph of a negro, changed racial characteristics were observed, and it is therefore possible that the process might find occasional use in ethnological studies.

There are, of course, many scientific applications of the infra-red method. The uses in spectroscopy are obvious, and need not be dealt with here at any length. If in any spectral region photographic material can be prepared which is sensitive to that region, it can be employed by any of the usual photographic methods.

Considerable use has been made of the infra-red method in astronomy. Professor Wright of the Lick Observatory has taken photographs of Mars, and the ordinary photograph shows the planet larger in size than the infra-red picture. It is thought that this increased image size is due to scatter of the shorter wave-lengths of the Martian atmosphere in a manner similar to that which occurs in the terrestial atmosphere. For the same reason (diminished scatter in the infra-red) the infra-red photograph reveals markings on the surface which are not visible on the ordinary plate. Trumpler, also of the Lick Observatory, has photographed the Orion nebula in this manner and has been able to obtain images of many faint stars invisible in the usual photograph. This is because the general light of the nebula, which is chiefly in the visible spectrum, blackens the photographic plate during the long exposures necessary, but with an infra-red filter such stars as radiate any infra-red are able to be recorded while the effect of the general scattered light is greatly reduced. Quite recently the infra-red spectrum of Venus has been photographed at the Lick Observatory. This shows the carbon dioxide bands in the atmosphere of Venus which do not exist in the solar spectrum. The spectrum of Venus, apart from this, is that of sunlight reflected from the clouds in its atmosphere.

With regard to microscopy, in working by transmitted light the spectral colour of the specimen, the method of preparation, and the stains used (if any), all affect the results obtainable. In those cases where the specimen is opaque, or nearly so, to visible light, but more or less transparent to infra-red, useful results may be expected and some of the work which has been done is not without promise. The photomicrographs show exterior detail as well as interior structure. Focussing and exposure present no special difficulties.

As a consequence of the peculiar results obtained in portraiture, it was considered that the photography of cases of skin complaint and of those suffering from such infectious and other diseases as produced markings on or beneath the skin, should prove of considerable interest. Insufficient work has been done to make any considered statement about this, but the results so far have not been very promising. Some recent pathological work, however, has provided interesting results. Experiments upon flesh penetration have also been made, but scatter of the light has hitherto prevented any considerable degree of success.

Uses in Medical Research.

A letter received from Copenhagen states that in the Rigs Hospital cases of lupus have been photographed in infra-red light. It was found that the photographs distinguished between dead skin and tissue and living skin with lupus nodules in it. A further interesting outcome of the work was that varicose veins not perceptible by the eye were clearly indicated in the infra-red photographs. We thus see that a highly specialized process such as this can have unsuspected applications, and that a knowledge of its powers and possibilities may not be without value in the course of technical work or scientific investigation.

This article is based on a lecture recently delivered by the author before the Royal Society of Arts.

In Search of the Panda.

The pandas of Western China are among the rarest animals in the world. New interest in these strange creatures has lately been aroused as a result of several expeditions to their domain in the upper basin of the Yang-tze river.

UNTIL the Roosevelt brothers shot a specimen of the giant panda, or parti-coloured bear, during their recent expedition into the Yunnan and Szechuan, no white man had seen a living specimen of this rare animal, although many, including the late General Pereira, had scoured the mountains of the Chinese-Tibetan border in search of it. Since this expedition, other explorers have succeeded in bringing specimens out of the country, but the Roosevelts alone can claim the distinction of having shot a giant panda.

Writing in the *China Journal*, Mr. Arthur de C. Sowerby, the authority on the natural history of the country, explains that the pandas, or cat-bears, form part of a small group of carnivores that occupy a position between the bear family on the one side and the weasel family on the other. The members of this group used to be classed together in the raccoon family and included the little panda of the South-eastern Himalaya and West China, the raccoon of North and Central America, the cacomistle of Mexico, the coati of Central and South America and the Kinkajou also of Central and South America. The giant panda was classed with the true bears. More intimate knowledge of the habits and anatomy of the pandas, acquired during the past few years as the result of the collection of specimens in West China by various zoological explorers, suggests, however, that this classification is not altogether satisfactory, and the author states that it would be more in keeping with the genetic facts of the case if the giant and little panda were placed together in a family by themselves, to which the name *Aeluridae* might be given.

THE LITTLE PANDA.

The little panda, or cat-bear, brought to Shanghai from Western Szechuan. The photograph is by Ah Fong and is reproduced from the *China Journal*.

Although in outward appearance there is considerable difference between these two animals, the giant panda in its size and general form being very bear-like, while the little panda is about the size and somewhat the shape of a cat, there is a marked similarity in certain details which indicate a common origin. Thus there is a resemblance in the general form of the skulls, giving the head a short-snouted rounded appearance, and an even closer resemblance in the teeth, particularly the molars, which are very broad and appear to be especially adapted to masticating the tough fibres of bamboo leaves and shoots, the main diet of both animals. Both the giant and the little panda have plantigrade bear-like feet, with the marked difference, however, that the soles are covered with fur. The colour markings of the two animals also suggest a close relationship, both having black about the face and ears and black legs with an inclination towards redness. There is further a similarity in the texture of the fur which is significant. Both animals are good climbers and extensively arboreal in their habits, and are found only in the highest and most rugged mountainous areas of West China, the little panda ranging south-westward into Nepal and the South-eastern Himalaya, which belong to the same faunistic region.

Full grown specimens of the giant panda weigh from two to three hundred pounds, and measure from four to five feet in length. As the tail is very short this measurement indicates a fair-sized animal. The Chinese name, *pei-hsiung*, meaning "white bear," refers to the colour of this remarkable creature, which is of a general creamy white. The front or inner surface of the ears is black, the eyes being encircled with the same colour. A black band extends over the shoulders and the legs, the feet, chest and throat also being black, in some specimens heavily tinged with a sort of chestnut red. The pelt consists of long glossy hair with a thick woolly under-coat. A stuffed specimen of the giant panda is to be seen in the British Museum (Natural History), while another is preserved in the

American Museum of Natural History in New York.

The food of the giant panda, as already stated, consists exclusively of bamboo, the animal appearing to eat not only the leaves and tender shoots, but also the hard fibrous stems. At least, this is the opinion of those, including Mr. Sowerby, who have hunted the animal and have examined its droppings. That this animal does not hibernate in winter as the true bears do is a generally accepted opinion, while the natives say that only during a very short mating season in spring is the giant panda anything but entirely alone. They also say that it frequently climbs and even sleeps in trees, though, judging from the experience of foreign explorers, it also uses hollow trees as sleeping quarters. It is not considered a dangerous or fierce animal by the native hunters, and the Roosevelts state that when they wounded the animal they secured, it went off without emitting any sound, which is quite contrary to the habits of the true bears.

The range of the giant panda is now admitted to be more extensive than was formerly supposed, while the animal itself is also less rare than it was believed to be. The denseness of the vegetation, alternating bamboo jungle and rhododendron forest, with jumbles of moss-covered rocks between, where rare primulas and ferns find shelter, is such, however, that it is extremely difficult to follow and get a glimpse of the animal. Mr. Sowerby states that his party came across indisputable evidence of the giant panda in the Tai-pei Shan region of South-western Shensi, where the local takin hunters described its appearance accurately and also showed the places where it had torn up the culms of the bamboos for food. From this region it ranges southward throughout all the wilder mountainous areas at least to the Yunnan border, everywhere being known to the native hunters by its name, *pei-hsiung*.

In the last two years over half a dozen good specimens of the giant panda have been secured for museums in America, the Dolan Expedition having secured enough specimens and data for a splendid habitat group.

The Little Panda.

The little panda is a very different animal so far as outward appearance goes. About the size of a large male cat, this delightful little creature, which becomes very tame in captivity has a fine thick almost woolly coat of a general bright rusty or chestnut red colour, with white ear-tips, a white spot over each eye, a white patch on each cheek and a white muzzle. The back of the ears, legs and feet are black, the red of the sides merging into black on the throat and under parts, while the tail is dark brownish, red banded with lighter rings and has a black tip. The round head, short pointed nose and white facial markings and ear-tips give the little panda a comic appearance. It is a remarkably good climber, and spends much of its time in trees, where it apparently sleeps. Its food consists very extensively of the leaves of bamboos, which it holds in its forepaws with the dexterity of a monkey. Mr. Floyd Tangier Smith, who secured many specimens of these animals in Szechuan, has expressed the opinion that they also live extensively on the long grey beard-like lichens that abound on the trees in the country they inhabit.

The "Nerve Impulse."

In a lecture to the Royal Institution last month, Professor A. V. Hill reviewed the latest investigations into the physical nature of the "nerve impulse." He explained that the properties of the nervous system are based upon the transmitted wave known as the nervous impulse. This wave, which is a few centimetres long, travels in nerve fibres of the order of 1/100th of a millimetre in diameter with velocities varying from a few centimetres to 100 metres per second. Its nature is not yet understood, but it possesses certain well-defined physical characteristics, and there would seem to be no reason why its nature should not be as clear some day as that of a sound wave or of an electromagnetic wave now is. The chief difficulty in investigating it is the minuteness of the changes involved in its passage: there is, for example, a rise of temperature, but this is only of the order of one ten millionth of a degree for each impulse, while the chemical changes which accompany this are at present altogether beyond detection.

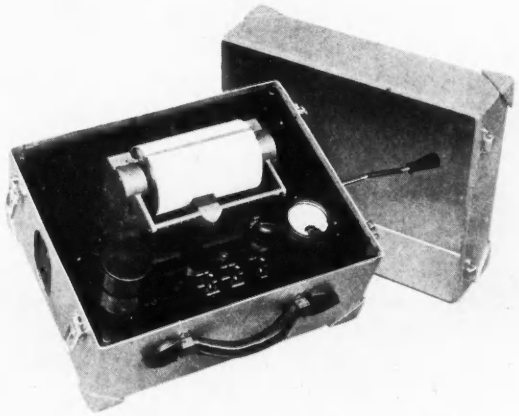
The electrical current produced at an active spot spreads out beyond it and induces similar activity there. The "activity" seems to consist of an alteration in the physico-chemical properties of the surface layer, allowing reaction to take place momentarily between inside and outside. The change is rapidly reversed, and the nerve is then ready to transmit another impulse. The passage of the wave involves the liberation of energy during, but chiefly after, the active process. Recovery lasts 30 to 50 minutes and requires oxygen. The nerve wave, therefore, is unlike a sound or electromagnetic wave, in which energy is not required during the transmission but only to start it. In other respects, however, the nerve impulse possesses wave-like properties, and its further investigation by physical means is likely to lead to a far greater understanding of living activity.

Studying City Noises.

Acoustic engineers are now engaged on a study of noise in the streets of London. An official survey of the same kind is being made for the city authorities in New York. The problems involved, and some of the delicate instruments employed, are here described.

THE study of acoustics was once described as an exact science inexactly applied. That, however, was in the days when "good acoustic conditions" was a characteristic purely of the concert hall or theatre. The advent of talking pictures widened the scope of this study and its application was extended to the cinema. This was followed by a study of commercial buildings affected by the noise of traffic, and now city streets themselves are being subjected to close examination with a view to reducing noise.

Until recently the interpretation of the human ear has been considered the final criterion in the study of sound problems. The sensitivity of the ear is not, however, constant, and data collected in this manner depends for its accuracy upon many factors, including the physical characteristics of the observer at the time of the observation. Excessive noise has long been considered harmful, but it is only quite recently that any serious attempts have been made to reduce it. The delay in attacking the problem has probably been due to the absence of any reliable media with which to measure the character of noise or to determine its source.



ONE OF THE NEW INSTRUMENTS.

The electric chronograph unit which forms part of the Western Electric apparatus for measuring noise in city streets.

Almost at the same time as the introduction of the talkies, however, came the successful development of accurate measuring apparatus. Organizations were established whose chief function was the study of acoustical problems. The Western Electric Company, who first introduced the talkie as an entertainment, set up an acoustic consulting group of trained engineers. This body is at present engaged on an elaborate survey of New York in an effort to reduce the excessive noise. Commercial organizations are seeking their advice, and office buildings are being examined, certain structural corrections made and existing building material treated to prevent the penetration of plant and street noise.

The terms "sound" and "noise," of course, describe two distinct problems which confront the acoustical engineer. His chief concern with noise—the conglomeration of disordered tones of varying pitch and volume—is simply its reduction or elimination, and the first step is the measurement of its intensity, the discovery of its source, and the analysis of its quality. While the human ear is useful in this study, it is not capable of sufficient accuracy to make possible the recording of reliable data. Sound, on the other hand, describes a series of arranged tones, such as music or speech, and the engineer is not concerned so much with the sound itself as with the treatment it receives from its surroundings. If, for instance, in designing a concert hall, sufficient attention has not been paid to acoustics, the structure on completion will have an echo which will entirely ruin the effect of the musical performances. It is here that the sound engineer is of service, either in the construction of a building or in the correction of structures lacking the necessary sound properties. The human ear can, of course, detect distinctive echo, and in tests of this kind a formula elaborated by Professor Sabine has been adopted. This provides that the human ear is not constant and gives misleading results for small chambers of under one or two thousand cubic feet, or large auditoria of over three million cubic feet capacity. The echo in cases such as this would be so indefinable as to be incapable of distinction by the human ear. The ear is not, however, treated with absolute disregard. It is merely insufficiently accurate. Instruments designed for noise and sound analysis must be capable of evaluating all the physical factors concerned, independent of the value of one or more of other noise factors.

An instrument known as the reverberation meter is now being used in the treatment of auditoria for the production of good acoustic properties, or for the correction of existing defects. This consists of three parts: a sound generator, a sound pick-up and a timing device. The generator is somewhat similar to a portable gramophone and uses discs, corresponding to the gramophone record, which have recorded on them steady notes of different frequencies or pitch. Incorporated with this is an amplifier, the whole unit being connected to a loudspeaker. The pick-up system comprises a microphone of extreme sensitivity, which is wired to an amplifier, this in turn being connected to the third item—the timing device, incorporating an electrically operated chronograph. In using these instruments for reverberation tests, sound is first generated by the " gramophone " through the loudspeaker and is picked up by the microphone. The sound is then cut off by a switch, which at the same time sets the chronograph in motion. When the sound thus generated has reverberated from wall to wall until it is no longer audible, an automatic relay stops the chronograph ; thus an accurate record of the reverberation period is made. Subsequent steps taken to correct the acoustic conditions are naturally influenced by the figure recorded. The measurements can be repeated, producing notes of varying pitch in different parts of the auditorium until a comprehensive record is made.

The value of this meter was adequately illustrated during the survey of the Madison Square Garden, New York. Using Professor Sabine's formula the reverberation period—with a note of 500 frequencies per second—was calculated to be over 20 seconds, whereas producing the same note but employing the meter, the period was recorded as under eight seconds, a correction of 12 seconds. With the former calculation the possibility of acoustic correction would appear to be hopeless and the cost excessive, whereas in the latter the prospect of improvement is easily possible and the expense within reasonable limits.

The study of noise as distinct from the study of auditoria acoustics involves the use of other delicate instruments. The sound meter, for instance, has been designed to measure loudness. This consists of a microphone, an amplifier, and a meter ; the latter possesses the necessary " hearing " properties and is equipped with a dial showing readings in decibels, the units in which noise is measured. An extension of the sound meter is the analyser, a complex device which permits the intensity of any sound to be determined. These instruments give a comprehensive analysis of all noise problems, and the data thus yielded allow steps to be taken towards noise reduction.

The solution of the problem involves the quietening of the sound at its source, such as the repair of faulty machinery, the isolation of vibration from any cause, structural alterations in order to localize the noise, or quietening through treating the subject under examination with the application of absorption material.

The data collected from a survey of a city can be invaluable as a guide in selecting sites for hospitals, churches, and buildings where quiet conditions are required. For many years attempts have been made to lessen the noise on the underground railways, so far with little success. The instruments here described, the first of which have just been sent out from the British laboratories of Western Electric, will bring the solution of this problem well within the bounds of possibility. As the future instruments of the acoustic engineer they will place this science on the same precise and accurate basis as that attained in other spheres of engineering.

Black and White in Africa.

THE future of the white and black races in Africa was discussed by Mr. F. H. Melland in a recent lecture to the African Society. The problem, he said, was to teach the black man to " think white " as we in many parts of Africa are endeavouring to " think black."

Mr. Melland therefore suggested that films of British life should be exhibited to the natives in an endeavour to illustrate more vividly the life of the white man in his own country. The speaker stressed the fact that the black man must be regarded as a permanent element in the future situation which must be taken into account ; he will not disappear as the red man in America or the blackfellow in Australia, nor will he survive merely as an historical curiosity. Mr. Melland mentioned the fact that the Bantu are the most virile and persistent racial stock extant, and in the highlands of Africa they outnumber the white man by fourteen to one.

Lord Buxton, who took the chair, urged the necessity for the scientific study of native ways of thought and institutions. There had recently been abundant evidence of difficulties in this direction, but the study of native life must be pursued on scientific lines if we were to ensure that progress in native development was in the direction which would permit of the two races living side by side in one community.

The Progress of Archæology.

Archaeologists announce several important discoveries this month, mostly from Greece. Space does not permit them to be dealt with individually in full-length articles, but the more outstanding finds are summarized in the following notes.

A LIFE-SIZE statue of a seated male figure belonging to the late sixth century has been discovered in Athens during building operations to the south of the Acropolis. There survives on the seat a painted design showing a panther-skin, which suggests that we have here a statue of Dionysos, and the figure may be an actual cult statue from a shrine. Similar seated figures of the same style are known, such as the seated Athena on the Acropolis, identified as the work of the artist Endoios. All alike seem to belong to the closing years of the sixth century, when east Greek influence had moulded Attic art into a definite manner. The seated Goddess at Berlin, said to come from Locri in Italy, is a similar sculpture. The surface of this statue is, in the undamaged parts, particularly fresh. It constitutes one of the more important acquisitions of the National Museum at Athens for some years past.

News from Troy is interesting. The American excavators have now concluded their first season. Much time was devoted to a general clearance and tidying of the site, which had suffered from the neglect of forty years and had fallen into serious disrepair. Now the walls of Troy, as excavated by Schliemann, can be seen in all their magnificence, standing in places to a height of forty feet. The excavators had made it their first duty to examine anew the stratification, and there are several areas in the citadel still undug where they have been able to achieve their object.

Their second main task was to search for the Trojan necropolis. In this they have been less successful, and only burials of the Roman period were found. Some five thousand yards of trenching were made in order to discover the necropolis, but nothing of the Homeric period has yet been found. On the other hand, they have discovered a curious area just outside the walls, surrounded by a terrace wall in which was a large accumulation of human and animal bones which had apparently been burnt. The excavators suggest with great reserve that possibly the solution of the burial customs of the Trojans is to be found here and that they used a common crematorium for the disposal of their dead. But at present there is nothing definite to confirm this unexpected hypothesis. Later excavations will confirm or refute it.

A find of unusual interest has been made at Corinth. It consists of a small altar of the type used either at small shrines or in domestic houses in the sixth century. On two sides of the altar are painted scenes, a photograph of which is reproduced. One shows the forequarters of a lion, the other a fight between a crane and a pygmy. Scenes of battles between cranes and pygmies are common in Greek vase paintings of the sixth century. The style of the painting on this altar is that of the group of vases known as Caeretan, from the fact that they were found at Caere in Etruria. The height of the altar is 13 centimetres. It is an importation to Corinth, perhaps from the west.

SCENES ON AN ALTAR FROM CORINTH.
The forequarters of a lion, and a fight between a crane and a pygmy. The latter is a common scene in Greek vase paintings of the sixth century.

The remarkable discoveries of Achaemenid sculptures at Persepolis remind us of the extent to which archaeological research is now indebted to expeditions sent out by the universities and museums of the United States. The work at Persepolis has been carried out by an expedition from the Oriental Institute of Chicago University, which has eleven expeditions at work in the East. Further details of the sculptures discovered will be awaited with keen interest. The addition of so much material for study—Dr. J. H. Breasted, Director of the Oriental Institute, estimates that it doubles that already known—cannot fail to add considerably to our knowledge of the Achaemenid empire and its culture.

Book Reviews.

Science in the Changing World. Edited by MARY ADAMS. (Allen & Unwin. 6s.).

Those who listened to the series of broadcast talks on "The Changing World" will welcome their collected publication in this book. The aim of the symposium is to reflect the crisis through which the world is passing, and it provides a critical and valuable analysis of the significance of scientific progress in the development of society.

The book is divided into three parts, in which the questions "What is Science?", "What is Man?" and "What is Civilization?" are debated. In a lucid contribution to the first part, Professor H. Levy defines the scope of scientific enquiry, and stresses the importance of the scientific outlook in studying the motives of human behaviour. He describes the fundamental nature of science as a process of systematic trial and error, of frustration and discovery, "a laborious construction of instruments, theories and methods of investigation." In a chapter entitled "Is the Universe Mysterious?" Professor Levy examines recent research connected with the electron and the quantum theory. He suggests that the layman's chief difficulty in understanding the "mysteries" of the universe is the fact that the electron is a scientific abstraction. If it were possible to get hold of a single electron and make experiments on it, we might manage to make short work of it, but since electrons exist in groups, they render themselves immune from too close a scrutiny. We have to deal, therefore, with the average of the group—the typical electron. As electrons are quite unlike anything science has ever experienced before, any discussion of matter involves an explanation in terms of electrons, hence our difficulties. Professor Levy shows how the newer physics in its study of the electron has led to a recognition of the fact that there are limitations to the field in which man can make accurate predictions: "But there is no mystery about this new limitation. It has not affected the determinism which was essential to scientific method before the recent developments in physics. Predictions which were made—and are still being made—on large-scale objects remain valid."

Writing on "Man as a Relative Being," Professor Julian Huxley reminds us that the revolutionary discoveries of modern physics have tended to eclipse the equally important change in the scientific outlook due to biology. The author shows how biology is helping us to a new intellectual outlook, in which man is seen not as a finished being, single lord of creation, but as one among millions of products of an evolution which is still in progress. Professor Huxley imagines a group of scientists from another planet, creatures with quite a different nature from ours, who had been dispassionately studying the curious objects called human beings for a number of years. They would not be concerned with what we men felt we were or what we would like to be, but only about getting an objective view of what we actually were and why we were what we were. In one of the most interesting chapters in the book Professor Huxley draws a picture of man as he might be studied from this point of view, and emphasizes the fact that, if humanity is to be brought under its own conscious control, it must cease taking itself for granted. Even though the process may often be humiliating, we must begin to examine ourselves in a completely detached and scientific spirit. Dr. John R. Baker also contributes some instructive chapters to this section of the book—on our place in nature, the evolution of mind, and the control of development.

The final section, "What is Civilization?", contains contributions from eminent and engaging writers in different fields, including Sir Oliver Lodge, Professor J. B. S. Haldane, Mr. Hilaire Belloc, Mr. Bertrand Russell, Mr. Aldous Huxley and Mr. Hugh I'Anson Fausset. In a concluding chapter on "The Spirit of Science," Sir Oliver Lodge distinguishes between science and what are only the applications of scientific knowledge to human purposes. These applications, says Sir Oliver, belong more to civilization than to science; they are more of the nature of engineering . . . The mind of man is ultimately the important thing; and that means the nature and amount of civilization. Science and civilization should work hand in hand. The real need, as Sir Oliver says, is for the community to encourage the workers in scientific research and next to have the goodwill to apply the discoveries on a large scale in beneficent directions.

The New World-Order. Essays Arranged and Edited by F. S. MARVIN. (Oxford University Press. 8s. 6d.).

This is the ninth collection of essays in the Unity Series, and is based on lectures delivered at two Unity Schools, at Danzig and at Stockholm. Dr. Marvin, who edits the series, contributes three chapters, on "The Chief New Thing," on contemporary education, and on race problems in industry and culture. He points to the emergence in men's consciousness of a sense of the unity of the world and its inhabitants as the most important fact in the post-war world. Dr. Marvin shows that, while this unity is no new thing, men woke up in 1920 for various reasons to realize as they had not done before how much they were bound up together, and took steps to make this implicit union conscious and effective. The League of Nations is fittingly taken as a starting point in these studies of the "new world-order"; the League is treated as a symbol of this spirit, as part of a great movement and set of organizations all having as their purpose to implement the new consciousness of world unity. Dr. Marvin notes the remarkable progress of science during the past fifteen years. It may well be, as he says, that this period will be remembered in the future for its scientific discoveries rather than for its political achievements.

Professor Herbert Dingle writes of the atom, and in a second chapter, of the universe. Two landmarks stand out in the period under review—relativity and the quantum theory. Professor Dingle deals attractively with the development of these momentous advances in scientific thought. He reminds us that atoms are the mental units out of which we build up rationally a description of the world which agrees with observation, but that they themselves are neither actually nor potentially a part of the world of observation. Atoms are simply mental concepts which do not conform with our notions of space and time. Professor Dingle describes the theory of the expanding universe as one of the great cosmogonical advances of recent years, and explains that the theory is not derived from direct observational evidence—although there is now such evidence of its validity, which makes possible tentative estimates of the size, age and rate of expansion of the universe—but from generalization of facts gathered mainly from the solar system. He points out that there is infinite variety possible for the structure of the universe, and which structure is actual can be determined only by observation; but whatever it may be it must conform to the general rule of a finite expanding

space. The writer emphasizes the fact that this rule is not something particular about the universe as it appears to be, but is a general characteristic of all possible universes. It does not follow, however, that it is established beyond possibility of error. It is quite possible that some mistake has been made, but the point is that it does not depend on the particular plan on which our universe has been constructed; the expanding universe is independent of all structural considerations.

Mr. Osbert Burdett discusses tendencies in recent English literature, and explains that his task resolves itself into an examination of the work produced in the decade that is just over. As a preliminary he takes a glance at the situation in 1913, which he describes as being characterized by a reaction against Romance. As dates by which to fix the tendencies discernible, Mr. Burdett mentions T. S. Eliot's "Prufrock" in 1917, Lytton Strachey's "Eminent Victorians" in 1918 ("both congenial to the opening mood of youth in the nineteen-twenties"), H. G. Wells' "Outline of History" in 1920, and two years later, James Joyce's "Ulysses." In the ensuing decade Virginia Woolf, Aldous Huxley, André Maurois and Dean Inge made their reputations, or as with the Dean, extended them to a more popular science. The author notes a stiffening of traditional opposition to scepticism and to the rebellions of the past decade among the outstanding tendencies. "There is a definite move towards the right, and a classical reaction towards authority and control. The notes of challenge and adventure are passing from the Romantic to the Classical camp, and initiative has returned to the latter."

Other contributors to the volume are Miss Dorothy Mackinnon, on the present position in biology, Mr. Östen Undén, on recent developments in international law, Mr. Ragnar Östberg, on some tendencies in Swedish architecture, and last but not least Mr. Hartley Withers on economic success and failure, and some aspects of international finance. It is a scholarly and instructive addition to a valuable series.

Studies in English Trade in the Fifteenth Century. Edited by EILEEN POWER and M. M. POSTAN. (Routledge. 21*s*.).

Professor Power and her fellow scholars have produced a most interesting book as the result of their intensive study of fifteenth century trade and taxation records. It says much for the completeness of these records that it has been possible to derive from them the details of the trade passing through sixteen ports between 1399 and 1482, while Professor Gray of Bryn Mawr has traced the rise and fall of our foreign trade between 1446 and 1482. And with these facts as a background there are essays on particular questions—the wool trade, the long dispute with the Hanse, the Iceland trade, the oversea trade of Bristol, the London grocers, and the Lancastrian Government's dealings with the Merchants of the Staple, which abound in new material and throw fresh light on political as well as economic history.

Professor Power's excellent study of the English wool trade reveals it as a highly complex business five centuries ago. Raw wool was England's main export; although English woollen cloths had already a great and growing reputation on the Continent, most of our wool went to feed the looms of Flanders and the Italian cities. And the trade not only enriched the sheep farmers of the Cotswolds and other districts but also supported a host of merchants and middlemen and contributed largely, in custom and subsidy, to the State revenue. England then was as dependent on the sheep as Australia is to-day. The demand for English wool, especially of the best sort, "Cotes" or Cotswold, was so urgent and widespread that the Crown could safely impose a high export duty and tax the foreign exporter at least a third more than the native. A contemporary estimate gives the average cost price of a sack of wool weighing 364 lb. in the Cotswolds as £8, and the customs, packing and transport charges to Venice as £6 11*s*., and adds that the Venetian sale price was about £20, so that the profits on a fortunate voyage, escaping shipwreck, pirates, thieves and accidental damage, were substantial. Professor Power shows that the trade was conducted largely on a credit basis, and that the capitalist played a great part in it. The risks were heavy, the losses no doubt considerable, but the wool men somehow contrived to make money and to build the fine churches and manor houses that enshrine their memory in many an English village.

Dr. Thripp's essay on the London grocer, based on the records of the Grocer's Company, is of exceptional interest. The Company was formed in 1345 to include the pepperers, the canvas-dealers and the spicers or apothecaries, an odd conjunction, and a generation later it adopted the name of "Compaygnie des Grossers." The members, all wealthy men, dealt in goods wholesale or *en gros*, and they had the right to appoint a weigher for the "King's beam" to which merchandise sold by weight—*averium ponderis* or *avers de poys* (our avoirdupois) had to be bought, except wool, which was weighed at the "Tron"—a term still familiar in Scottish towns though forgotten in London. The grocers also had the right to clean or "garble" spices and wax, so as to prevent adulteration; spices that did not bear the garbler's stamp could not be weighed at the great beam. Strong in the control of these offices, the grocers' company soon became almost as powerful in the City as the mercers. It is interesting to find that "the typical grocer was a general merchant but one who could usually be relied on to keep spices." He sold wool and cloth and sometimes even retailed wine; he dealt in metals and dyes. It was long before be specialized in the wares which we now associate with a grocer, though they formed the larger part of his business. The common belief that mediaeval trade was narrowly specialized is evidently wrong as far as the City of London was concerned. The temptation to refer to many other interesting points must be resisted. Suffice it to say that Professor Power and her collaborators have produced a book which no student of economic history can afford to neglect.

The Archaeology of Yorkshire. By FRANK and HARRIET WRAGG ELGEE. (Methuen. 10*s*. 6*d*.).

The "County Archaeologies," edited by Mr. T. D. Kendrick of the British Museum, are supplying a real need in the best possible way. For each volume gathers up from many sources and presents in an attractive style the main facts regarding the country with which it deals, from the Stone Age to the Norman Conquest. All the seven volumes so far issued are very good, but Mr. and Mrs. Elgee's new book deserves specially warm commendation because they have had to deal with the largest county, and with a county, moreover, whose early history is peculiarly complex and difficult, and yet have triumphantly succeeded. Mr. Elgee is well known for his long and patient studies of the stone circles and barrows, on which his "Early Man in North-East Yorkshire" (already reviewed in *Discovery*) is based. But the authors show themselves as well acquainted with the Romans, Anglian and Scandinavian remains in Yorkshire as with the prehistoric antiquities. Moreover, they keep the amateur archaeologist in mind and, while concentrating on

the principal monuments, are careful wherever possible to relate past and present by anecdotes and reminiscences—as of the farmers who until lately continued to set up stone pillars in their pastures for the benefit of their flocks, or of the shepherds in the Pennine dales who still use Celtic numerals in counting their sheep.

The history of Yorkshire, broadly speaking, is a history of successive invasions by different peoples coming directly or indirectly from the Continent. The authors help us to distinguish clearly between them, both by their relics and their choice of habitation, whether on the Wolds, the moors or the plains. To the hunters of the Old Stone Age succeeded pastoral Neolithic man who buried his dead in long barrows. Then came the Beaker folk of the Early Bronze Age, who preferred round barrows, and they in turn had to face new invaders, the Urn folk who cremated their dead and who built megaliths. In the late Bronze Age appeared another people using bronze swords and living in pile-dwellings by the streams. Three or four centuries before Christ the formidable race who had weapons of iron, and who were doubtless Celts, overran Yorkshire. They were known to the Romans as the Brigantes; they built hill-forts and had war chariots and a rude coinage, whose types derive, oddly enough, from the gold stater of Philip of Macedon, Alexander's father. With the Roman conquest of these vigorous people, Yorkshire history becomes clearer and the authors give an admirable survey of the many important Roman remains at York and elsewhere, including the recently discovered signal stations which formed part of the system of coast defence against pirates. When the Romans left, the pirates took their place, Anglians being followed by Danes and Norwegians, some of whom came from the Viking settlements in Man and Ireland. It is curious to note that a Norse king of Dublin was ruling at York in the middle of the tenth century. But Yorkshire had always had Irish connexions. From the remote past Continental traders had traversed Yorkshire on their way to Ireland for gold and copper; the route through the Aire Gap, where the canal now crosses the Pennine, is one of the oldest in the world. The volume is well illustrated, and the gazetteer gives handy references to the antiquities of each town or district.

Southern Cross to Pole Star. Tschiffely's Ride. By A. F. TSCHIFFELY. (Heinemann. 15s.).

Mr. Tschiffely's account of his ride from Buenos Aires to Washington is a fascinating book. He had two sturdy Argentine *criollo* horses from Patagonia, aged sixteen and fifteen years respectively, and with them he climbed mountains higher than Mont Blanc, traversed deserts and jungles, and swam rivers, to say nothing of bandits and fevers, in the course of a ride of 10,000 miles. The swamps of Southern Pamana and a revolution in Nicaragua prevented him from passing through these countries. On the rest of the route neither physical nor human obstacles could stop him and his horses, Mancha the piebald and Gato the dun, and the book is a plain record of his experiences, free from all superfluous matter and enlivened with the comments of a kindly, observant and highly educated man.

The author has a gift for describing scenery and people. The reader who follows him on the long trail, through Western Argentina and across the Bolivian tableland to the Andean province of Peru, over the mountains to the desert coast, up into the lesser ranges that traverse Ecuador and Colombia, through Northern Panama, San Salvador and Guatemala, where forest-clad mountains proved all but impassable, and across the whole length of Mexico to the Rio Grande, will have a clear-cut impression of each country and of the condition of its inhabitants. The author never wastes words, but his brief notes and anecdotes suggest that the Indians in tropical South America are very decent folk who suffer under the misrule of the local officials, usually *mestizos* or half-breeds. Mexico, after the smaller republics, proved to be a horseman's paradise, where the author made an almost royal progress; but even there he did not fail to note the destruction wrought by civil war. Mr. Tschiffely endears himself to the reader by his good nature. He was kind to his horses, as a skilled horse-master should be, and he was rewarded for his care of them. One horse was badly kicked by a mule in Guatemala, but "Mancha" had no serious mishap until a brutal American in West Virginia deliberately drove his car at the horse and knocked him over. But Mr. Tschiffely knew how to manage men as well as horses. For many months he was riding through wild country and amid semi-barbaric people, but he rarely met with discourtesy and seldom indeed had to draw his pistol as a threat.

For most of the two years and a half he was alone. An amateur archaeologist scrambled up and down the Andes with him for a few weeks. A native boy went with him from Ecuador to Colon, and he had a guide further north to the Guatemalan border. But Mr. Tschiffely with his two horses was a host in himself. His long residence in Argentina and his thorough command of Spanish, together with the letters of commendation accorded him by the Government at Buenos Aires, were, of course, advantages that few European travellers in South America enjoy. Yet he made the very most of his opportunities, and his book will take its place at once as a classic of travel. The many illustrations, though small, are of great interest.

The Rise of the British Coal Industry. By J. V. NEF. Two Vols. (Routledge. 42s.).

"The general economic and social development of the period from 1550 to 1700 cannot be understood unless account is taken of the part played in it by the coal industry." Such is Mr. Nef's thesis. He has proved it by his extremely valuable and interesting study of coal mining and marketing up to the early eighteenth century, which throws much new light on a neglected aspect of our economic history. Few people before him have realized how revolutionary was the change from wood to coal as the ordinary fuel for industrial and domestic purposes, when wood became scarce and dear as it did in the Tudor Age.

The Corporation of London up to 1543 was accustomed to distribute firewood to the poor, but from 1554 it brought coal for the same charitable object. Within the years 1580-1615 London's imports of coal increased ninefold, from 10,000 to 91,000 tons, and grew rapidly thereafter. The yearly British coal output between 1551 and 1560 is estimated at 210,000 tons. By 1690 it had increased fourteen-fold. Mr. Nef invites us to consider the meaning of such figures. They involved, clearly, a new employment for capital and labour, a new demand for all kinds of colliery plant, for roads and wharves and shipping. New villages sprung up in the coalfields and brought new elements into the old agricultural communities. The marketing of coal at home and abroad became a large and profitable business, the like of which had not existed before. All the implications of this revolutionary change are fully worked out by Mr. Nef, on the basis of long research in the Public Record Office and elsewhere. He often illustrates political history, as when he points out that, when London became dependent on Newcastle

for fuel, enemy attacks on the collieries, as in the Dutch wars, had to be guarded against. When Charles I occupied Newcastle in 1642, he threatened the Parliaments' hold over London, whose coal supply was thus interrupted. Then, again, the rapidly growing coal trade, while producing new wealth, raised many new and difficult problems, both financial and administrative, for the Stuarts and the Commonwealth.

Mr. Nef observes that we were the first nation to work our coal measures on a large scale, that we were thus enabled to develop our native industries more quickly, and that here lies the true reason for the lead that we took in manufactures long before the steam-engine was improved by Watt and made an efficient source of power in factories. His excellent book, in fact, must modify current conceptions of English economic history which tend to ignore all that happened outside the textile trades in the later eighteenth century. It abounds in interesting detail, it is attractively written, and it takes its place at once as the standard work on the subject.

Nature by Day. By ARTHUR R. THOMPSON. (Nicholson and Watson. 12*s*. 6*d*.).

This handsome book is a sequel to the author's "Nature by Night," and the two form a record of observations in the field which every nature lover should possess. In an opening chapter on mammals, the author has much of interest to say about the observations of otters by day. These creatures probably change their quarters more frequently than any other British mammal and have thus survived continual persecution. But the otter does incredibly foolish things when hunted and is often easily killed on that account. Generally speaking the otter is, of course, nocturnal; to observe it in the daytime requires special knowledge of its hiding quarters and, as the author says, an element of luck. Badgers never come abroad in the daylight, although they are sometimes obliged to remain out of their setts after daybreak when these have been stopped to prevent foxes from going to ground. There are some interesting photographs of the otter, one of which shows it treading water.

Writing of the birds of the field and woodland, the author rightly says that it is only partly correct to think of birds as shy, quick creatures, for ever moving from side to side, and darting away at the slightest alarm. "When birds fancy themselves, their jerky movements disappear." Blackbirds, as we know, are confiding birds; the author has set up a camera and exposed four plates less than three feet from the nest and come away leaving the female bird sitting. Among birds of the sea-shore the gannet holds a precarious position; its known breeding stations total less than twenty. Mr. Thompson points to the danger from collectors which threatens all rare birds.

In a chapter on birds of the mountain and moor, the author cites the red grouse as a classic example of the foolishness of over-preservation. The bird receives rigid protection against its enemies, but is much given to disease. As the author points out, when a bird's natural enemies have been killed off, diseases, contagious or infectious, spread more rapidly and more completely than is the case if a number of predatory animals are in existence on the same moor. Even if it is admitted that many carnivorous animals kill more than they require, it is a simple fact that they kill where killing is easiest. Thus a peregrine falcon coming suddenly upon a brood of grouse subconsciously strikes the nearest. If disease is on the moor, the weakening birds are more liable to be killed off than the more vigorous, and the chances of the disease spreading are greatly reduced. Mr. Thompson reminds us that in seasons when disease is rampant, over-stocked and over-preserved moors suffer more than moors which still carry a sufficiency of natural checks upon weaklings.

There are also interesting chapters on fish, reptiles and butterflies, and the whole is a fascinating record, well written and attractively presented, with over a hundred illustrations.

Nonsuch. Land of Water. By WILLIAM BEEBE. (Putnam. 21*s*.).

Readers of Dr. Beebe's previous works will agree with the statement on the wrapper of this volume that his books are the *belles lettres* of natural science. It is not only what he says, but the way he says it, that attracts and fascinates.

The Bermuda Islands, of which Nonsuch is one, are volcanic. Ages ago they "nosed their way to the upper air" through some two miles of ocean. But above the volcanic rock are strata of limestone superimposed in places on beds of red loam, the result of successive glacial and inter-glacial epochs. From Nonsuch Dr. Beebe explores the wonders of the ocean in his motor launches. One of his favourite diversions is "dangling": arrayed in his diving helmet and one or two other trifles, he descends down forty-five feet of metal ladder, and having reached the lowest rung, swings his feet and legs free in the depths.

It is difficult to select episodes when every chapter is a fairy tale. "Slicking" for flying fish consists in netting these partial amphibians from a launch steered along "slicks," i.e., smooth lanes of sea amid rough water, while the boat perpetually rises and falls in the swell. Dr. Beebe likens this "tremendously exciting" sport to "pigsticking from a stand on horseback, or butterfly catching from a surf-board." The gorgeous colours of these "butterflying fish" are beautifully delineated in the frontispiece. Their eggs are deposited in compact balls of sargassum weed held together with fine silken threads; Dr. Beebe's description of their development and the emergence of the young in his aquarium reads like a Lilliputian miracle.

The adult sea-horse (*Hippocampus punctulatus*) might be described as a deep sea chameleon in that it can suffer a sea-change, e.g., from brown to green to suit its environment. Its method of reproduction is another marine marvel. During courtship the female discharges the eggs from her ovary into the water, and "by some instinctive bit of magic" they are slipped into a pouch which, "like the pocket of a kangaroo" is suspended in front of the male. "Incubation" lasts four weeks, and then the male ejects the young sea-horses from his pouch in successive masses shaped "like a smoke-ring or a bomb from a firework." From the male's resemblance to a chess-board knight Dr. Beebe dubs him "a motherly knight in armour." There is feminism among fishes as well as among birds such as phalaropes.

Space forbids more than a passing mention of the Bermuda cedar—really a juniper—which grows on Nonsuch. On the northern and sheltered side the trees develop strongly, but on the southern side, where they are exposed to the prevailing wind, they are dwarfed and prostrate; yet some of these stunted growths are 276 years old. There are two chapters on bird-migration and another on the breeding habits of dusky shearwaters and yellow-billed tropic birds. A chapter on "weather" includes a thrilling description of a hurricane, and, writing on "snail folk" the author relates the moon snail's ruthless way with limpets. This cannibalistic mollusc climbs on the limpet's shell, bores a hole with a moving belt of minute

teeth, hacks its prey into small fragments and devours it piecemeal. Besides the coloured frontispiece the book is profusely illustrated with nearly fifty photographs.

Greece and the Ægean. By ERNEST A. GARDNER. With a Preface by SIR RENNELL RODD, and a Chapter on Constantinople by S. CASSON. (Harrap. 7*s*. 6*d*.).

If the intelligent visitor to Greece and the Ægean can be content with a single volume on these fascinating lands, he will be well advised to take and read Professor Ernest Gardner's excellent little book. It embodies in an attractive form the experience of a lifetime in Greek travel and Greek history and art. Professor Gardner does not try to be exhaustive, or to condense a library into a small octavo. He wisely deals with the more famous places and with the more notable things that should be seen. Brief and useful chapters on travelling in Greece and on the people and the modern language open the book. Three judicious chapters are given to Athens and the district; one of them, very rightly, is devoted to the Museum, where the whole long and brilliant history of Greek art can be conveniently studied. The reader is then conducted on a rapid tour of Central and Northern Greece, with a full account of Delphi, and afterwards through the Peloponnese, with special attention to Olympia. Later chapters describe the more notable islands and the sites on the Asiatic coast. Mr. Stanley Casson contributes an illuminating chapter on Constantinople; the latest results of research, in which he has taken an active part, are compactly recorded. The book is illustrated with 32 well chosen photographs, several maps and plans and a coloured plate of the Propylaea in its unrestored condition, and there is a good index. As an introduction to a great subject, nothing could be better than this delightful volume, which will assuredly send many people to Greece this spring.

Scrutiny of Cinema. By WILLIAM HUNTER (Wishart: the Adelphi Quartos. 5*s*.).

Mr. Hunter's aim in this book is "to assess the cinema's present achievement and possible future," and he is not optimistic. "Every year," he writes, "the menace of the super-cinema assumes even more alarming proportions, and with the definite establishment of the talking film, becomes more potent than ever as an anaesthetic and an instrument of cultural levelling-down." The author has neglected to qualify this sweeping statement, and appears to be writing purely of the film "fan." The post-war development of the cinema from a crude and silent moving-picture show to a social and artistic force worthy of intelligent notice has attracted a new public, to whom it is by no means an "instrument of cultural levelling-down." The superb German productions of recent months, among which "Mädchen in Uniform" is outstanding, are at least a hopeful sign to those who see a future for the cinema through less pessimistic eyes than Mr. Hunter's.

The author mentions the "horrible implications" of the technical improvements now fast being perfected: the cheap appeals to participate in a crude and unhealthy experience, he says, will be still more compelling, and the effect on the life and mental attitudes of the community will be, to say the least, alarming. This morbid prophecy has no foundation. Further progress will increasingly attract the intelligent student, as it has done in the past, and should serve to raise the cinema to a still higher artistic level. Mr. Hunter is right in pointing to the appallingly low standard of film criticism in the Press, which bears no comparison with contemporary dramatic criticism.

The book is handsomely illustrated with "stills" from some of the best of recent films, and is altogether a neat production. It is worth the price in spite of its title.

The Life of Birds. By T. A. COWARD. (Black. 2*s*. 6*d*.).

The publishers observe that the "How and Why" series, to which this little book belongs, is intended to appeal not only to "any alert child of ten" but also to elders. This volume certainly fulfils these conditions. It is written in clear and simple language, gives the essential facts, and never declines into that pseudo-humanistic interpretation of the behaviour of birds which still sometimes disfigures books written for children and others. Propounding the question "Does a bird think?" the author says "one thing is quite certain—the bird's mind is not like ours: it works in quite different ways." And again, when writing of "the Enemies of Birds," he explains that though birds are always alert, we need not think that they are in a constant state of fear.

Explaining a bird's choice of territory, Mr. Coward reminds the reader that the bird knows what it wants and takes care that it gets it, though we may not understand its reasons. Nests, eggs and the feeding of the young are described, and a useful outline sketched of migration. One chapter deals with the value of birds to man, and the book ends with some wise comments upon bird protection. Mr. Coward says he is old enough to remember the conditions fifty years ago when anybody shot any rare bird and stole whatever eggs he wanted. The law has done much to alter this, but the growth of the love of *living* birds has done far more. We do not know a better book on birds to put in the hands of young children. There are some pleasant illustrations by Mr. Roland Green. As we go to press we regret to learn of the author's death, a distinct loss to ornithology.

Scotty. The Adventures of a Highland Fox. By FRANCES PITT. Illustrated by PERSIS KIRMSE. (Longmans. 10*s*. 6*d*.).

Those who remember the chapters on the fox in Miss Pitt's book "The Intelligence of Animals," will know that she understands its psychology. In this story she illustrates her conclusions by the life of "Scotty," who, spared from a litter destroyed by a keeper on a Highland grouse moor, is transported as a small cub to the Midlands, where he is kept in confinement. He escapes, and eventually, after divers adventures, returns to his native country.

These adventures give an accurate and intimate insight into a fox's life. "Scotty, like all foxes and most other animals, lived in a world composed largely of odour . . . fear and joy came to him chiefly through his nose." We understand his sometimes wanton playfulness, the keenness which blinded him to all else when in pursuit of his quarry; and see how he learned by experience what to avoid and how; we admire his devotion to his mate and cubs, and perhaps what is most important, realize how, in common with other wild animals, he lived in the present. "Fear and worry pass quickly in the wild world. Sufficient unto each minute are the troubles that come, so anger, fear and grief, like cloud shadows racing over the hills, are here one moment and forgotten the next." Thus the book is not only a story but a study in the psychology of the fox and incidentally of other untamed inhabitants of the countryside. It is beautifully illustrated by Persis Kirmse.

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